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

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** LFSV

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

See Current Range.

**Current Range**

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

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated

**Lifespan**

Adult: perennial species (USFWS, 2022)

**Breeding Season**

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

**Key Resources Needed for Breeding**

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

**Other Reproductive Information**

Adult: Large-fruited sand-verbena flowers open from 3:00 or 4:00 pm until 9:00 or 10:00 am and produces a strong sweet aroma resembling honeysuckle that increases until early evening. These floral characteristics are commonly associated with moth pollination (Corlies 1991, p. 12). Williamson et al. (1994, p. 339) observed, captured, and identified several floral visitors of LFSV which included Sphynx and Noctuid moths (family Sphingoidea and Noctuidae, respectively) such as the black alder or pawpaw sphynx (Dolba hyloeus), lettered sphynx (Deidamia inscripta), obscure sphynx (Erinnyis obscura), and large necklace moth (Hypsoroph monilisi). The probosci of these moths were dusted with LFSV pollen, making them likely pollinators. Furthermore, the larval food sources for these likely pollinators have been noted at all of the LFSV sites and include yaupon (Ilex decidua), grape (Vitis spp.), and milkweed (Asclepias spp.) (Figure 3, In Williamson 2008, p. 18; Table 9, In USFWS 2010, pp. 18-22). Among the diurnal floral visitors, some incidental pollination may be due to bees (genus Bombus and Apis) (Williamson et al. 1994, p. 339). Noted pollinator observations of various other Abronia species including Yellowstone sandverbena, pink sand-verbena, and Ramshaw Meadows sand-verbena (A. alpina, RMSV) support the notion that species of Abronia are moth pollinated (Saunders and Sipes 2006, p. 80; Jabis et al. 2011, p. 1587; Doubleday 2012, p. 23). Pollinator observations included mostly moths including Noctuids and some Sphingids, Geometrids, and Pyralids; however, bumblebees and butterflies were also noted as potential pollinators. While observational studies provide insight into potential pollinators, it is important to determine if those visitations result in plant reproductive output (i.e., the production of fruit and seed set and effective pollination). Doubleday and Eckert (2018, p. 71) found floral visitation of pink sand-verbena was higher during the day (8.67 percent) compared to those visits at night. Yet nocturnal visitation by Sphingid moths resulted in significantly higher seed set, suggesting Sphingid moths are the primary pollinators. Moreover, while honeybees were observed during this study their visitations resulted in no fruit/seed set suggesting that these insects are acting as potential pollen thieves, collecting floral pollen/nectar but not necessarily pollinating the flowers (USFWS, 2022).

**Reproduction Narrative**

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

**Habitat Vegetation or Surface Water Classification**

Adult: Post oak savanna (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

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

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1992)

**Habitat Narrative**

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

***Dispersal/Migration***

**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

**Dispersal/Migration Narrative**

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

***Population Information and Trends***

**Population Trends:**

Not available.

**Species Trends:**

Stable (inferred from USFWS, 2010)

**Number of Populations:**

10 (USFWS, 2022

**Population Size:**

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

**Population Narrative:**

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

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

***Threats and Stressors***

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

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

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

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

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

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

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

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

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

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

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

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

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

***Recovery***

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

Recovery Priority Number: 8

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

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

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

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

***Conservation Measures and Best Management Practices:***

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

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

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

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

**References**

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# SPECIES ACCOUNT: *Aeschynomene virginica* (Sensitive joint-vetch)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** SJV

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

**Physical Description**

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

**Taxonomy**

In the pea family, Fabaceae (USFWS, 1995)

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Insect (USFWS, 2019)

**Breeding Season**

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

**Key Resources Needed for Breeding**

<u>Adult:</u> Small bumblebees, some self-pollination (EPA, 2016)

**Reproduction Narrative**

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

**Habitat Vegetation or Surface Water Classification**

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

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

**Species Trends:**

Decline of 10-30% (NatureServe, 2015)

**Number of Populations:**

Approximately 20 (NatureServe, 2015)

**Population Size:**

Approximately 7000 individuals (NatureServe, 2015)

**Adaptability:**

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

**Population Narrative:**

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

***Threats and Stressors***

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

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

***Recovery***

**Reclassification Criteria:**
Not available.

Recovery Priority Number: 2

**Delisting Criteria:**

1. The sensitive joint-vetch and the ecosystems upon which it depends are adequately protected within the following six watersheds: Manokin Creek in Maryland; Manumuskin River in New Jersey; and Rappahannock, Pamunkey, Mattaponi, and Chickahominy Rivers in Virginia (USFWS, 1995).

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

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

**Recovery Actions:**

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

research efforts to introducing the species into new upstream sites. Guidelines should be developed in case more aggressive management strategies are warranted (USFWS, 2013).
- Surveys should be conducted in potential habitat throughout the range of the species (USFWS, 2013).
- Revise the recovery plan to update information and to consider the incorporation of the James River Basin in the Recovery Criteria (USFWS, 2013).

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# SPECIES ACCOUNT: *Agalinis acuta* (Sandplain gerardia)

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

See current range/distribution.

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

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

**Dependency on Other Individuals or Species**

Adult: Insects for pollination (EPA, 2016)

**Breeding Season**

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

**Reproduction Narrative**

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

**Habitat Type**

Adult: Terrestrial (USFWS, 1989)

**Habitat Vegetation or Surface Water Classification**

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

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

**Dispersal/Migration Narrative**

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

***Population Information and Trends***

**Population Trends:**

Not available.

**Species Trends:**

Increase of > 10% (NatureServe, 2015)

**Number of Populations:**

22 - 23 (NatureServe, 2015)

**Population Size:**

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

**Population Narrative:**

While there are about 6 sites with reasonably large, stable, well managed populations, few have good viability/integrity. "Large" represents a population that has maintained an average of 3000+ individuals over the past 5 years. Many populations are still very small or occur on marginal habitat such as small expanses of grassland surrounded by development or unsuitably dense vegetation (NatureServe, 2015).

### *Threats and Stressors*

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

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

### *Recovery*

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

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

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

Recovery Priority Number: 5C

**Delisting Criteria:**
Not available.

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

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# SPECIES ACCOUNT: *Agalinis navasotensis* (Navasota False Foxglove)

***Species Taxonomic and Listing Information***

**Listing Status:** Proposed Endangered

**Physical Description**

The description provided by Canne-Hilliker & Dubrule 1993 (pg. 426-431) is as follows: Navasota false foxglove is an annual herb from a few fibrous roots, 2.8-9.0 decimeter (dm) tall, often tinged with purple, maroon, or bronze. Stem erect or sometimes declined, single from the base, divaricately branched above, terete to slightly angled below the branches. Leaves opposite, spreading to ascending or often recurved filiform, 0.5-1 millimeters (mm) broad, 1.2- 3 centimeters (cm) long, acute to acuminate. Pedicels slender, terete, spreading or ascending, glabrous to minutely scabridulous and always longer than the calyx. Calyx somewhat campanulate or funnelform, straight sided. Tube 2.2-3.7 mm long, 3-4 mm broad, unribbed, exterior glabrous, interior with a narrow band of capitate hairs below the sinuses and lobes; lobes triangular-subulate, 0.5-1.5 mm long, sinuses broad and straight to slightly concave. Corolla including lobes 16 – 25 millimeters (mm) long, lavender to rose-purple. Corolla paler in the larger blossoms and darker in the smaller, throat paler than lobes, with darker spots and two pale yellow lines abaxially. Tube 2-3 mm long, narrow, glabrous. Stamens didynamous, abaxial filaments 9-11 mm long, villous; adaxial filaments 5-6 mm long; sparingly villous. Anthers of abaxial stamens usually coherent by entangled hairs; thecae villous, 2- 3.2 mm long. Style 1.5 cm long, pubescent; stigma 2 - 4.5 mm long, densely yellow-papillate. Capsule 4-7 mm long, conspicuously longer than the calyx, 4- 4.5 mm broad, ovoid-or obovoid-oblong. Seeds 0.8-2.3 mm long, dark brown, irregularly trapezoidal, testa reticulate, radial walls of reticulae densely thickened, inner tangential walls with an irregular pattern of spinulose thickenings (USFWS, 2022).

**Taxonomy**

The currently accepted taxonomic classification of Agalinis navasotensis (Navasota false foxglove) is as follows: Order: Scrophulariales Family: Orobanchaceae (broomrape) (Pettengill and Neel 2008 & Flora of North America (c)) Genus: Agalinis Raf. (false foxglove) (Flora of North America (b) Species: Agalinis navasotensis (Canne-Hilliker & Dubrule 1993 & Flora of North America (USFWS, 2022).

**Historical Range**

Navasota false foxglove is a narrowly endemic, hemiparasitic, annual plant known in only two counties in southeast Texas, Grimes and Tyler counties (USFWS, 2022).

**Current Range**

Navasota false foxglove is a narrowly endemic, hemiparasitic, annual plant known in only two counties in southeast Texas, Grimes and Tyler counties (USFWS, 2022).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: Navasota false foxglove have not been researched, but specialists hypothesize that little bluestem (Schizachyrium scoparium) is one of the main plants that it parasitizes (Reed, pers. comm. 2020). Little bluestem occurs in all three current source features for Navasota false foxglove. Also, the co569 occurring King Ranch bluestem (Bothriochloa ischaemum var. songarica), a non-native, invasive grass, could serve as a potential beneficial host but could also out-compete it for sunlight, if not managed (Strong and Williamson 2015, pg. 6). Currently, both species of host plants inhabit areas where Navasota false foxglove are found. These host plants provided needed nutrients for survival and reproduction of Navasota false foxglove, especially in drought years (USFWS, 2022).

**Breeding Season**

Adult: Blooms from mid-September to October, and seeds mature from October to early November (USFWS, 2022).

**Reproduction Narrative**

Adult: Little is known about specific reproductive biology for Navasota false foxglove, but inferences can be made from other Agalinis species. The reproductive age of false foxgloves is less than 1 year. False foxgloves need pollinators and are structured like typical bee-pollinated flowers with nectar guides and an open throat, but they can also self-pollinate. Corollas are present for one day only and drop by the end of the day. As a corolla falls, it drags the anthers and stigma together, effecting pollination (Pennell 1921, pgs. 515-525). Numerous dark brown seeds (0.8-2.3mm) are encapsulated within a 6-7 mm long (Canne-Hilliker & Dubrule 1993 p. 430), ovoid to obovoid-oblong fruit; not all seeds will germinate in a single year and not all seeds in a capsule are viable. Navasota false foxglove blooms from mid-September to October, and seeds mature from October to early November. Fruit maturation and seed dispersal occurs by November, with other Agalinis fruit typically containing between 50 and 180 seeds (USFWS, 2022).

**Habitat Type**

Adult: Terrestrial (USFWS, 2022)

**Habitat Vegetation or Surface Water Classification**

Adult: Remnant prairie (USFWS, 2022)

**Habitat Narrative**

Adult: The EO# 6674 (East) site is a remnant prairie on a rocky sandstone outcrop representing the easternmost escarpment of the Oakville formation. The soils consist of rock outcrop and sandy loam over sandstone. Plants occupy open areas of the outcrops where sun exposure is nearly constant. In 1967, Keeney presented his thesis on the “Flora and Ecological Relationships of the Easternmost Extension of the Oakville Formation of Texas.” Keeney’s study on the soil-plant relationships on the outcrop areas of the Oakville sandstones revealed several interesting findings, including that the soils are a major factor in determining flora distribution and that segregation of species exists when limiting factors (plant structure, soil types, adequate water, base rock material, etc.) within a particular area are complex. Plants inhabit soil types specific to their individual needs, therefore soil mapping can identify flora distribution based on specific soil types. Mapping these specific soils can provide information for species distribution, which can help narrow down survey areas specific to certain rare plant species. Isolation of species in the case of the Navasota false foxglove is limiting due to exposed rocky outcrops and well drained soils being a need for this species. Keeney described ten different factors in his thesis where soil-plane relationships can be used (Kenney 1967, pg. 5-6). At the EO# 6674 (East) site, most of the plants occur on exposed rock formations, similar to the habitat at EO# 6674 (West) site. The EO# 9000 site is an outcrop of the Catahoula Formation within a pine plantation and surrounding pine savannah. Soils consist of fine sandy loams and clay. The Catahoula formations are similar to the Oakville formations found in Grimes County, but many of the plants at this site were not near exposed rock like the ones in Grimes County. Soils at the EO# 9000 site tend to be hard when dry, and when wet the thick clay becomes sticky and slick (Reed et al 2005, pg. 3). Microhabitats The soils were analyzed at the current Navasota false foxglove locations to determine the habitat features of areas that are currently occupied. The Grimes County sites (EO# 6674 East and West) are within a formation described as renish-rock outcrop complex. Plants are located on 8 to 20 percent slope and Brenham clay loam. Grimes County is within the Catahoula formation that extends across most of the eastern and southern parts of Texas (Map 2 below). The EO# 9000 site has soils that are described as Colita fine sandy loam and are within the Browndell-Kittrell complex, stony. Individual plants occur on slopes of 1 to 3 percent in the former soil and 5 to 15 percent slopes on the latter soils. Navasota false foxglove has only been found in areas where these formations are exposed to the surface, producing shallow, well drained soils. Map 2 illustrates soil types that were selected for projecting soils and potential habitat features that are like currently occupied habitat conditions based on description and knowledge of soils in the areas of occupied sites. The description of these soil types varies across databases and counties, so it is difficult to determine which soil types are closely related across county lines. While developing and evaluating the soil and rock layers, it was determined that there is a lot of uncertainty between county boundaries and soil mapping. The soil mapping was helpful as a visual representation of the areas that could potentially be Navasota false foxglove habitat, but it was not ground-truthed and did not provide any increased probability that could be used to determine potential survey areas or critical habitat mapping (USFWS, 2022).

***Dispersal/Migration***

**Dispersal**

Adult: Fruit maturation and seed dispersal occurs by November, with other Agalinis fruit typically containing between 50 and 180 seeds (USFWS, 2022).

***Population Information and Trends***

***Threats and Stressors***

**Stressor:** very few 139 populations (low redundancy) (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** small population size (USFWS, 2022)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:**

**Stressor:** encroachment of woody vegetation (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** non-native grass invasion (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

***Recovery***

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Amaranthus pumilus* (Seabeach amaranth)

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Annual seed production (USFWS, 1996)

**Lifespan**

Adult: Less than one year (USFWS, 1996)

**Breeding Season**

Adult: April to January (USFWS, 1996)

**Other Reproductive Information**

Adult: Probably wind pollinated (USFWS, 1996)

**Reproduction Narrative**

Adult: Flowering of the Seabeach Amaranth begins as soon as plants have reached sufficient size, typically commencing in July and continuing until their death in late fall or early winter. Seed production begins in July or August and reaches a peak in most years in September; also continuing until the plant dies. Seeds are regularly produced by nearly all adult plants; fertility is assumed to be high (Baskin and Baskin 1994). The relative roles of the fresh seed crop and banked seeds from previous years are unknown in seabeach amaranth. Weather events (including rainfall, hurricanes, and temperature extremes) and predation by webworms can significantly reduce the length of the reproductive season. Based on morphology of the flower and inflorescence, seabeach amaranth is probably wind-pollinated, as are most species of amaranth.  It is clear that seabeach amaranth is capable of self-pollination, and it is likely that self-pollination plays a large, probably dominant, role in seed production.Seeds may survive many years buried in the sand; they germinate when brought near the surface by severe storms. The seabeach amaranth is a classic example of a fugitive species--”an inferior competitor which is always excluded locally under interspecific competition, but which persists in newly disturbed habitats by virtue of its high dispersal ability; a species of temporary habitats” (Lincoln et al. 1982). (USFWS, 1996)

**Habitat Type**

Adult: Terrestrial (USFWS, 1996)

**Habitat Vegetation or Surface Water Classification**

Adult: Sparsely vegetated sand (USFWS, 1996)

**Dependencies on Specific Environmental Elements**

Adult: Requires tidal overwash (USFWS, 1996)

**Geographic or Habitat Restraints or Barriers**

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

**Spatial Arrangements of the Population**

Adult: Sparse (USFWS, 2007)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1996)

**Habitat Narrative**

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

***Dispersal/Migration***

**Motility/Mobility**

Adult: Moderate for seeds (USFWS, 2007)

**Dispersal**

Adult: Moderate for seeds (USFWS, 2007)

**Dispersal/Migration Narrative**

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

**Additional Life History Information**

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

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2023)

**Species Trends:**

Declining (USFWS, 2023)

**Number of Populations:**

21 - 300 (NatureServe, 2015)

**Population Size:**

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

**Adaptability:**

Low (inferred from USFWS, 2007)

**Population Narrative:**

Given the fugitive nature of the species and the constantly changing environment where it occurs, it is difficult to make determinations about population size or trends based on limited data from annual surveys which had only been conducted for the last ten years (as of 2007). Northern populations are generally seen as declining, but southern populations fluctuate significantly, which is consistent with its occurrence in a geologically dynamic landscape. Total seabeach amaranth numbers reported in 2005 range-wide surveys were the lowest since 1999. Annual census data indicate up to 100,000 individuals, with up to 300 populations. However, in many cases, groups of existing mapped sites should be lumped to represent single, dynamic populations. Once the occurrences are re-mapped in this fashion, the range-wide number may be on the order of 30-50. (USFWS, 2007; NatureServe, 2015); USFWS provided detailed Census Data on the Seabeach amaranth in the addendum to the 2007 5-year review (USFWS, 2018). The nine historically occupied States identified in the plan are: Delaware (DE), Massachusetts (MA), Maryland (MD), North Carolina (NC), New Jersey (NJ), New York (NY), Rhode Island (RI), South Carolina (SC), and Virginia (VA). These recovery criteria have only been partially met. The natural range of seabeach amaranth includes Atlantic Coast barrier beaches, from Cape Cod, MA south to Charleston, SC, with the exception of CT where no plants have ever been reported (Figure 1.) Natural populations of seabeach amaranth currently persist in five states: NY, NJ, DE, MD and NC. The single population in SC persists mainly due to annual plantings. Seabeach amaranth is an annual species and therefore the number of individual plants observed at a population in any given year fluctuates greatly as the species goes through boom-and-bust years. Prior to 2000, surveys were inconsistent and focused mainly on NY, NC and SC beaches and total numbers were between 3,000 and 34,000. Since 2000, more consistent range-wide surveys have been conducted in NY, NJ, DE, MD, NC and SC. Limited surveys also occurred in MA and VA following the 2017 reintroductions, but plants have not been found there in recent years. Between 2000 and 2020, the range-wide numbers varied from a high of 249,261 in 2000 to a low of 1,323 in 2013. During the early 2000s (2000-2003), very large populations of seabeach amaranth (~200,000 plants) were found on Long Island, NY. Those numbers dropped off significantly in 2004 (~31,000 plants) and reached their lowest numbers in 2010 and gradually increased from 2014 to 2019. NJ populations reached a low in 2013, the year after hurricane Sandy decimated beaches there and in NY. The numbers in NY and NJ have rebounded some since the 2013. In NC, historically a stronghold for this species, numbers have declined since 2005 with only a few plants found state-wide in recent years. This reduction in resiliency and redundancy may be attributable to shorter hurricane return period in Carolinas compared to NJ and NY (NOAA 2023). The total number of plants, range-wide, is much less than it was in the early 2000s with only 6,964 plants found in 2020. The species was reintroduced to MA and VA in 2017, but those populations have not persisted. Unfortunately, 75% of the sites with suitable habitat within each state have not been occupied by seabeach amaranth for 10 consecutive years. Seabeach amaranth is an annual species and populations fluctuate from year to year. Some populations that occurred in excellent habitat and were considered stable in the past have not been seen for several years (USFWS, 2023).

***Threats and Stressors***

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

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

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

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

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

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

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

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

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

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

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8C

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

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

(USFWS, 2007)

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

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Abiotic, Insect (EPA, 2016)

**Breeding Season**

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

**Key Resources Needed for Breeding**

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

**Reproduction Narrative**

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

**Habitat Type**

Adult: Terrestrial (USFWS, 2018)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal grasslands and shrublands (USFWS, 2018)

**Geographic or Habitat Restraints or Barriers**

Adult: Low elevations; 26 to 66 ft

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2018)

**Habitat Narrative**

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

***Dispersal/Migration***

**Motility/Mobility**

Adult: N/A

**Dispersal/Migration Narrative**

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

***Population Information and Trends***

**Population Trends:**

Not available.

**Species Trends:**

Not available.

**Number of Populations:**

7 (USFWS, 2019)

**Population Size:**

Uncertain (USFWS, 2019)

**Population Narrative:**

As of 2014, there are seven extant, or presumed extant, ambrosia populations from north-central Kleberg County through north-central Nueces County. One site occurs on state land, on both the north and southbound ROWs of US Hwy 77. The largest population occurs on Federal land at the Naval Air Station Kingsville (NASK). There are two sites on city or county-owned lands; the Bishop City Park and the Nueces County Park in Robstown. Two sites are located on private land, including a large population at the St. James Cemetery in Bishop and a small group of plants on a lot in Kingsville (General Cavazos Boulevard). Additionally, a National Guard training area formerly leased from a private landowner, known as the KRTA, has several sites (Table 9). These KRTA populations became inaccessible and thus unverifiable after the lease expired in the mid-1990s. Observations using Google Earth show the habitat still exists and the ambrosia is assumed to be extant. All of these separate KRTA occurrences are less than 1.0 kilometer (km) (3, 280 feet (ft)) apart and may therefore be a single metapopulation. The same is true for the occurrences in the St. James Cemetery, Bishop City Park, and the US Hwy 77 ROW, as well as the separate patches of ambrosia on NASK (see paragraph below). If the ambrosia is sexually reproducing, the close proximity between occurrences allows for the genetic exchange between each occurrence, or sub-population, and may mean that these sub-populations constitute at least 3 different metapopulations based on these distances. The population at Robstown and the one in Kingsville would be considered separate populations. (USFWS, 2018)

***Threats and Stressors***

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

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

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

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

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

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

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

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

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

***Recovery***

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

Downlisting Criteria 2: Each ambrosia site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie habitat should contain species commonly associated with ambrosia (see Table 7 of 2018 Recovery Plan). Although ideal high quality shortgrass prairie habitat would be located in unplowed/undisturbed habitat areas, this scenario means only remnant pieces of land in Nueces County which has been largely converted to cropland, and is restricted in Kleberg County to areas that can be accessed for plant surveys. As a consequence, existing patches of shortgrass prairie may need intensive restoration or habitat may need to be created on areas that are currently devoid of vegetation due to previous land use. Unplowed/undisturbed habitats should be sought out and restored as a priority before attempting creation of new habitat amidst disturbed shortgrass prairie. Prolific and aggressive nonnative grasses and woody species should not constitute more than small patches within each high quality shortgrass prairie site and these undesirable species should not be spreading throughout the site or inhibiting growth and reproduction of ambrosia. Each ambrosia site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat and to minimize and control threats over a period of 20 years. (USFWS, 2018)

Recovery Priority Number: 8

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

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

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

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

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

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

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

***Conservation Measures and Best Management Practices:***

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

**References**

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

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

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

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USFWS. 2010. South Texas Ambrosia (Ambrosia cheiranthifolia)

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

Yes; 11/30/2010.

**Legal Description**

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

**Critical Habitat Designation**

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

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

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

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

Unit 4: San Luis Rey River Watershed: Unit 4 is located in northwestern San Diego County and consists of four subunits of approximately 17 ac (7 ha) of State or local government-owned land and approximately 74 ac (30 ha) of privately owned land, for a total of approximately 91 ac (37 ha). Subunit 4A: Calle de la Vuelta Subunit 4A is located near junction of State Route 76 and Calle de la Vuelta in unincorporated San Diego County. Subunit 4A consists of approximately 0.8 ac (0.3 ha) of State or local government-owned land and 14 ac (6 ha) of privately owned land, for a total of approximately 15 ac (6 ha). No lands in Subunit 4A are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4A contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, road maintenance activities, and future widening of State Route 76. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 4B: Olive Hill Road Subunit 4B is located on the west side of State Route 76, south of Olive Hill Road in unincorporated San Diego County. Subunit 4B consists of approximately 16 ac (6 ha) of State or local government-owned land and approximately 8 ac (3 ha) of privately owned land, for a total of approximately 23 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 4B are conserved (a portion of Subunit 4B is within the Groves mitigation preserve, managed by the California Department of Transportation (Caltrans); this area has not yet been conserved). The occurrence in this subunit was erroneously considered extirpated at the time of listing, but has since been found to be extant. Like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4B contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and flooding presumed necessary for the plant's persistence (PCE 1), and grassland vegetation which allow adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, road maintenance activities, and future widening of State Route 76. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 4C: Jeffries Ranch Subunit 4C is located approximately 0.7 mi (1 km) southwest of Bonsall Bridge, adjacent to the south side of State Route 76 in the City of Oceanside, San Diego County. Subunit 4C consists of approximately 0.1 ac (0.05 ha) of State or local government-owned land and approximately 33 ac (13 ha) of privately owned land for a total of approximately 33 ac (13 ha). No lands in Subunit 4C are conserved. This subunit was occupied at the time of listing and, like all other extant occurrences, we believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4C contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, road and utility maintenance activities, future widening of State Route 76, and potential development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 4D: Gird/Monserate Hill Subunit 4D is located in the Fallbrook area of northern San Diego County, California. This subunit is adjacent to the north side of State Route 76, almost equidistant from Gird Road (to the west) and Monserate Hill Road (to the east). Subunit 4D consists of 0.7 ac (0.3 ha) of State-owned land and 20 ac (8 ha) of privately owned land, for a total of 21 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 4D are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we believe this subunit is also essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4D contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1); and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, from human encroachment that may occur in the area, and from development and road maintenance. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Unit 5: San Dieguito River Watershed— Lake Hodges: Unit 5 is located in central San Diego County and consists of two subunits comprised of approximately 129 ac (52 ha) of State or local government-owned land and approximately 121 ac (49 ha) of privately owned land, for a total of approximately 249 ac (101 ha) (values do not sum due to rounding). This total does not include a portion of Subunit 5B (52 ac (21 ha)) that we have excluded from this designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule). Subunit 5A: Lake Hodges East (Via Rancho Pkwy) Subunit 5A is located on the west side of Interstate 15, just north of Lake Hodges and south of Via Rancho Parkway in San Diego County. Subunit 5A consists of approximately 16 ac (6 ha) of State or local government owned land and approximately 5 ac (2 ha) of privately owned land, for a total of approximately 21 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 5A are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 5A contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, utility maintenance activities, and potential development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 5B: Lake Hodges West—Crosby Estates Subunit 5B is located just west of Lake Hodges in the western portion of central San Diego County, California. This subunit is on and adjacent to the west side of the Crosby National Golf Club. Subunit 5B consists of approximately 113 ac (46 ha) of State or local government owned land, 115 ac (47 ha) of privately owned land for a total of approximately 228 ac (92 ha) (values do not sum due to rounding). This subunit meets the definition of critical habitat for this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 5B contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, from human encroachment that may occur in the area, and from golf course maintenance. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

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

Unit 7: Sweetwater River Watershed:  Unit 7 is located in southwestern San Diego County and consists of three subunits containing approximately 146 ac (60 ha) of federally owned land (San Diego National Wildlife Refuge), approximately 13 ac (5 ha) of State or local government owned land, and approximately 57 ac (23 ha) of privately owned land, for a total of approximately 215 ac (87 ha) (values do not sum due to rounding). Subunit 7A: Jamul Road Subunit 7A is located southeast of the City of El Cajon at and near junction of Jamul Road and Steele Canyon Road, on the north and south sides of Jamul Road. Subunit 7A consists of approximately 3 ac (1 ha) of State or local government owned land, and approximately 36 ac (15 ha) of privately owned land, for a total of approximately 39 ac (16 ha). No lands in Subunit 7A are conserved or managed for biological resources. This subunit was occupied at the time of listing and remains occupied. This subunit, like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7A contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, alterations of site hydrology, and offhighway vehicle use. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 7B: San Diego National Wildlife Refuge (SDNWR) Subunit 7B is located on the San Diego National Wildlife Refuge, south of Sweetwater River between Rancho San Diego Golf Course and the hills to the south, and on the north and south sides of a dirt trail adjoining the end of Par Four Drive in unincorporated San Diego County. Subunit 7B consists of approximately 118 ac (48 ha) of Federal land owned and managed by the Service, and approximately 15 ac (6 ha) of privately owned land, for a total of approximately 133 ac (54 ha). No private lands in Subunit 7B are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329 see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7B contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require continued management and protection on federally owned lands to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 7C: Steele Canyon Bridge Subunit 7C is located mainly on the east side of State Route 94 on a slope between a concrete-lined ditch and a fence adjacent and parallel to State Route 94, approximately 0.7 mi (1.1 km) southeast of Subunit 7B, in unincorporated San Diego County. A small portion of the subunit is located on the opposite side of State Route 94 just south of Steele Canyon Bridge in a split-rail exclosure. Subunit 7C consists of approximately 28 ac (11 ha) of federally owned land managed by the Service, approximately 10 ac (4 ha) of State or local government owned land, and approximately 6 ac (2 ha) of privately owned land, for a total of approximately 44 ac (18 ha) (values do not sum due to rounding). No private or state/local government owned lands in Subunit 7C are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7C contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require continued management and protection on federally owned lands to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

**Primary Constituent Elements/Physical or Biological Features**

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

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

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

**Special Management Considerations or Protections**

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

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

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

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

**Lifespan**

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

**Breeding Season**

Adult: May - October (USFWS, 2010)

**Key Resources Needed for Breeding**

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

**Reproduction Narrative**

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

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

**Habitat Type**

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

**Habitat Vegetation or Surface Water Classification**

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

**Geographic or Habitat Restraints or Barriers**

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

**Spatial Arrangements of the Population**

Adult: Colonial (USFWS, 2010)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2010)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 2010)

**Habitat Narrative**

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

***Dispersal/Migration***

**Dispersal/Migration Narrative**

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

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

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

**Population Size:**

Unknown (USFWS, 2010)

**Adaptability:**

Low (inferred from USFWS, 2010)

**Population Narrative:**

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

***Threats and Stressors***

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

**Stressor:** Nonnative plants (USFWS, 2010)
**Exposure:**

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

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

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

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

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

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

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

***Recovery***

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

Recovery Priority Number: 11C

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

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

- Determine whether a program to propagate Ambrosia pumila in greenhouses and outplant the resulting plants in unoccupied areas would be biologically sound and feasible (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Little is known of the life history of crenulate lead-plant. In two years of life history monitoring of one population, no seedlings were observed. Plants showed little to no growth and flowered primarily following human disturbance. Crenulate lead-plant is semi-deciduous, about 70 percent of plants losing most or all leaves between December and February. Pollinators or dispensers have not been observed (DERM 1993). New sprouts, when observed, have been identified as primarily adventitious roots (DOT 1997). In addition, the viability of germplasm is not known (DOT 1997). This species is relatively easy to cultivate, indicating that the lack of reproduction in the wild may not be due to a lack of viable seeds (A. Herndon, personal communication 1998). (USFWS, 1999)

**Habitat Type**

Adult: Pine rocklands

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

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

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

5 populations (USFWS, 2019)

**Population Size:**

~ 650 individuals (USFWS, 2019)

**Population Narrative:**

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

***Threats and Stressors***

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

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

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

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

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

*Recovery*

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

Recovery Priority Number: 5C

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

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

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

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

**Recovery Actions:**

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

Plant Society, Everglades National Park, and Miami-Dade County DERM. Support of local press coverage should continue. DERM has developed a web page that will also aid in disseminating information about this endangered plant community to the public. (USFWS, 1999)

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

Yes; 6/7/1985.

**Legal Description**

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

**Critical Habitat Designation**

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

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

**Primary Constituent Elements/Physical or Biological Features**

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

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

**Special Management Considerations or Protections**

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

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

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

**Lifespan**

Adult: < 1 year (USFWS, 2009)

**Dependency on Other Individuals or Species**

Adult: Possibly A. edwardsii (USFWS, 1997)

**Breeding Season**

Adult: Spring (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Fall/winter rain (USFWS, 2009)

**Reproduction Narrative**

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

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal grasslands (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unavailable (USFWS, 2019)

**Species Trends:**

Stable (NatureServe, 2015)

**Number of Populations:**

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

**Population Size:**

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

**Population Narrative:**

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

***Threats and Stressors***

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

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

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

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

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

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

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

***Recovery***

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

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

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

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

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

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

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

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

**Recovery Actions:**

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

be identified and tested for suitability as reintroduction sites. Specific establishment test sites must be selected, secured, and managed. (USFWS, 1997)
- Determine delisting criteria . Information gathered needs to be analyzed to establish delisting criteria. Genetic factors also need to be studied to determine if they are limiting
- Secure the Carnegie Canyon population. The Carnegie Canyon population should be secured from a willing seller by fee title for the benefit of several listed species (USFWS, 2009).
- Conduct a management study whose first objective is the establishment of 6 to 10 acres of thriving Amsinckia grandiflora populations with the ultimate objective of determining what factors enable and prevent sufficient recruitment to sustain the populations. This study would be done in a completely controlled and intensively managed basis. Amsinckia grandiflora has been grown successfully in greenhouses, but we do not know why it is not thriving in the wild. Such a study would provide the information needed for recovery, while maintaining the seed stocks and as much genetic variability and adaptability as is needed to implement recovery. The expanded scale would also allow the study of more extensive techniques and the study of more kinds of management techniques simultaneously (USFWS, 2009).
- Maintain seed bank to have viable seeds for restoration (USFWS, 2009).
- Determine causes for the extirpations of the natural and reintroduced occurrences and remedy the decline of Amsinckia grandiflora (USFWS, 2009).
- Conduct a study to help determine the effect of grazing and other vegetation management on Amsinckia grandiflora populations and the restoration of perennial grasslands (USFWS, 2009).
- Conduct surveys to try to locate additional natural occurrences of Amsinckia grandiflora (USWS, 2009).

***Conservation Measures and Best Management Practices:***

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

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

**Dependency on Other Individuals or Species**

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

**Breeding Season**

Adult: June through September (NatureServe, 2015)

**Other Reproductive Information**

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

**Reproduction Narrative**

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

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

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

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

**Environmental Specificity**

Adult: Broad (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

**Dispersal**

Adult: Low (NatureServe, 2015)

**Dispersal/Migration Narrative**

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

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Stable (USFWS, 2022)

**Number of Populations:**

57 (USFWS, 2022)

**Adaptability:**

Relatively resistant (NatureServe, 2015)

**Population Narrative:**

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

***Threats and Stressors***

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

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

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

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

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

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

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

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

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

**Stressor:** Climate change (USFWS, 2022)
**Exposure:**

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

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 8

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

**Recovery Actions:**

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

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

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

possible (USFWS, 2016).

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

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery criteria and actions is presented in the species' recovery plan (Service 1993). In conducting this status review new and/or targeted potential recovery activities were identified and are included below. These actions are recommended to support and promote recovery of Price's potato-bean. Use of a numbered list for these recommendations is for convenient reference only and does not necessarily imply prioritization of any activity over others. Recovery Activities 1. Continue efforts to work with local governments and highway officials to reduce threats associated with roadside maintenance, including installing signage, training staff and contractors on appropriate management techniques and avoidance measures, and establishing cooperative agreements, when possible. 2. Continue management at Land Between the Lakes National Recreation Area and Sauta Cave National Wildlife Refuge to reduce canopy cover and invasive species encroachment and promote flowering, seed production, and population growth. Encourage similar management efforts at other protected sites. 3. Work cooperatively with the National Park Service and U.S. Forest Service to develop conservation strategies for populations at Fort Donelson National Battlefield in Tennessee, Natchez Trace National Parkway in Mississippi, and Bankhead National Forest in Alabama. 4. Collaborate with State and Federal agencies to initiate and perform feral hog eradication and control efforts across the range of Price’s potato-bean. 5. Work with landowners of protected sites to develop conservation agreements that establish biological goals for Price’s potato-bean, identify management strategies to achieve those goals, and include a monitoring plan for measuring effectiveness of conservation efforts as related to the species’ status. 6. Work cooperatively with the Chickasaw Nation to develop strategies for expanding populations at Chickasaw Preserve in Mississippi, while also increasing protections for the existing population. 7. Ensure that ex situ accession information and propagation protocols are maintained and curated in the Center for Plant Conservation National Collection of Endangered Plants centralized database. Monitoring and Research Activities 1. Work with state Natural Heritage Programs, National Park Service, U.S. Forest Service, National Wildlife Refuges, and other partners to establish a consistent range wide monitoring program. 2. Coordinate with the National Park Service, Mississippi Natural Heritage Program, and other partners to identify suitable outplanting strategies and locations at Natchez Trace Parkway in Mississippi. 3. Build on earlier experimental studies that examine the species habitat needs to develop/improve management protocols that bolster population size and fitness. Future work should include design of experiments to examine the response of natural or experimental populations to fire, canopy thinning, herbicide application, and other management tools, as well as to emerging threats.

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# SPECIES ACCOUNT: *Arabis georgiana* (Georgia rockcress)

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

Yes; 9/12/2014.

**Legal Description**

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

**Critical Habitat Designation**

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

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

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

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

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

Unit 5. Durant Bend, Dallas County, Alabama: Privately owned, the 12-ha (28-ac) Durant Bend unit occurs 16 km (10 mi.) east of Selma in a sharp bend on the Alabama River. Fewer than 50 plants were reported in sandy alluvium along the Alabama River under a partially open to filtered canopy in 2010 (Schotz 2010, p. 37). While the majority of plants occur in forested conditions, a small number of plants were observed in relatively open and exposed soils of actively eroding sections of the riverbank. Nonnatives, including Chinese privet and Japanese honeysuckle, are present but not severe. Timber harvesting has recently taken place approximately 46 m (150 ft) north of the site, but it currently has not impacted species' viability or habitat integrity (Schotz 2010, p. 37). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

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

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

Unit 8A. Cottingham Creek Bluff and Unit 8B. Pratts Ferry, Bibb County, Alabama: Privately owned, the Cottingham Creek Bluff subunit is located on the east side of the Cahaba River, upstream of Pratts Ferry Bridge, 10 km (6.2 mi) northeast of Centreville, Alabama. The Pratts Ferry subunit is located on the west side of the Cahaba River, downstream of Pratts Ferry Bridge, 10 km (6.2 mi) northeast of Centreville, Alabama. A small portion (26 percent (5.88 ha (14.5 ac)) of the Cottingham Creek Bluff subunit is owned by The Nature Conservancy (TNC). A small number of plants are confined to an abandoned limestone quarry several hundred feet back from the southeastern side of the river's edge. Chinese privet and Japanese honeysuckle impact this site, particularly in the vicinity of the abandoned quarry. Nonnatives could become worse. Timber harvesting is of potential concern in an area adjacent to the population on the west side of the Cahaba River, which was selectively logged in the 1990s (Allison 1999, p. 3; Schotz 2010, pp. 34–35). Subunit 8A is 22 ha (55 ac), and subunit 8B is 11 ha (28 ac). In 2010, these two subunits together contained 299 Georgia rockcress plants. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with road crossings, timber harvest, and nonnative species.

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

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

Unit 11. McGuire Ford/Limestone Park, Bibb County, Alabama: Privately owned, the McGuire Ford/ Limestone Park unit is located 18.7 km (11.6 mi) northeast of Centreville, Alabama, on the southeast side of the Little Cahaba River. A small number of plants occupy shallow soils of low, rocky limestone outcrops along the Little Cahaba River under a lightly shaded canopy of eastern red cedar, chinquapin oak, white ash, Southern sugar maple, and redbud, among others (Allison 1999, p. 5; Schotz 2010, p. 20). This 6-ha (15-ac) unit contained 50 Georgia rockcress plants during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, development, and maintenance of a pasture.

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

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

Unit 14A. Goat Rock North and Unit 14B. Goat Rock South, Harris and Muscogee Counties, Georgia:  Privately owned, the Goat Rock Dam is 18.5 km (11.5 mi) north of Columbus Georgia. The Goat Rock North subunit is immediately north of Goat Rock Dam on the banks of Goat Rock impoundment, while the Goat Rock South subunit is immediately downstream of Goat Rock Dam along the high bluffs overlooking the Chattahoochee River. All of Goat Rock North subunit and the majority of the Goat Rock South subunit are owned by a corporation that supports conservation efforts for Georgia rockcress. The corporately owned property is provided modest protection in the shoreline management plan, which was developed during Federal Energy Regulatory Commission (FERC) licensing (FERC 2004, pp. 29–30). However, the southernmost portion of the Goat Rock South subunit is privately owned. This high rocky bluff is mostly covered by a mature canopy of trees. A narrow portion of this habitat has a transmission line passing over the top where all woody species have been removed; however, Georgia rockcress plants are scattered in the transmission line right-of-way. This area contains PCEs 1 and 2; therefore, it is included in the final designation. Nonnative species, including Chinese privet and Japanese honeysuckle, have severely impacted this site (Allison 1995, pp. 24– 27; Moffett 2007, pp. 6–9). Conservation actions here have included invasive species/woody competition removal (both manually and chemically) to benefit existing Georgia rockcress plants, and prescribed burning to open up new adjacent sites for outplanting enhancement. The Chattahoochee Nature Center (CNC) outplanted approximately 300 Georgia rockcress plants of the Goat Rock genotype at this site in 2008. The local office of TNC has also expressed interest in possibly including this site in their long-range ecosystem planning (Elmore 2010, pp. 1–3). Subunits 14A and 14B are 7 ha (19 ac) and 24 ha (59 ac), respectively, and contain two or more of the PCEs throughout the subunits. In 2007, approximately 1,000 Georgia rockcress plants were found scattered across these subunits. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with hydropower, utility line maintenance, and nonnative species.

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

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

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

**Primary Constituent Elements/Physical or Biological Features**

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

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

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

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

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

**Special Management Considerations or Protections**

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

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2013)

**Dependency on Other Individuals or Species**

Adult: Pollinators (inferred from USFWS, 2013)

**Breeding Season**

Adult: March - April

**Reproduction Narrative**

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

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

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

**Dependencies on Specific Environmental Elements**

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

**Geographic or Habitat Restraints or Barriers**

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

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Species Trends:**

10 - 30% decline (NatureServe, 2015)

**Resiliency:**

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

**Representation:**

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

**Redundancy:**

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

**Population Growth Rate:**

Unknown (NatureServe, 2015)

**Number of Populations:**

17 (USFWS, 2021)

**Population Size:**

~ 5,000 plants (USFWS, 2013)

**Adaptability:**

Low (inferred from USFWS, 2013)

**Population Narrative:**

No studies have been conducted on population dynamics and reproduction biology. However, based on field inspections, recruitment appears low. Most occurrences are small, containing only a few plants. This species has experienced a short-term decline of 10 - 30%; although many occurrences have remained relatively stable over the past 10-20 years, some have decreased in size primarily as a result of invasive species, logging, and succession. (NatureServe, 2015). Currently, 18 populations are documented to occur across Alabama and Georgia. Georgia rockcress is rare throughout its range. Moffett (2007, p. 8) found approximately 2,140 plants from all known sites in Georgia. Moffett (2007, pp. 1–2) indicated that the overall status of the three populations in the Ridge and Valley ecoregion (Floyd and Gordon Counties, Georgia) was poor, as these populations tended to be small, and declining in size and vigor. Schotz (2010, p. 8) documented fewer than 3,000 plants from all known sites in Alabama. Only the Goat Rock Dam and Fort Benning populations are sufficiently large (greater than 1,000 individuals) to preclude a genetic bottleneck (Schotz 2010, pp. 13–57; Moffett 2007, p. 8) (USFWS, 2013). Georgia rockcress continues to be threatened with extinction throughout its range. Only about half (9 of 17) of the extant Georgia rockcress populations are currently resilient (good to excellent resiliency) and more than 75 percent of the populations are threatened by habitat degradation from invasive plant species. In the future under "Status Quo" conditions, only four to two populations are expected to be resilient in 20 to 40 years, respectively, without additional conservation efforts which may be facilitated by the ESA and prioritized with ESA protections and recovery programs. (USFWS, 2021)

***Threats and Stressors***

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

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

**Stressor:** Climate change (USFWS, 2013)

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

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

### *Recovery*

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

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

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

***Conservation Measures and Best Management Practices:***

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

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USFWS. 2021a. Species status assessment report for the Georgia rockcress (Arabis georgiana), Version 1.0. January 2021. Atlanta, GA. 125 pp. 121 pp.

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

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

**Breeding Season**

Adult: April - May (USFWS, 2013)

**Reproduction Narrative**

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

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

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

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (USFWS, 2013)

**Geographic or Habitat Restraints or Barriers**

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

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Decline of 30-50% (NatureServe, 2015)

**Species Trends:**

10 - 30% decline (NatureServe, 2015)

**Number of Populations:**

34 (NatureServe, 2015)

**Population Size:**

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

**Population Narrative:**

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

***Threats and Stressors***

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

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

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

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

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

***Recovery***

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

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

Recovery Priority Number: 14C

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

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

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

4. An ex situ collection of plant material is established in a Center for Plant Conservationaffiliated botanic garden. A soil seedbank would typically provide a strategy for a species to regenerate populations in the face of stochastic events as well as natural senescence;

however, this species is known to be susceptible to high rates of seed predation. (USFWS, 2019)

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

**Recovery Actions:**

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

***Conservation Measures and Best Management Practices:***

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Historical Range**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect (EPA, 2016)

**Breeding Season**

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

**Key Resources Needed for Breeding**

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

**Reproduction Narrative**

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

**Habitat Type**

Adult: Terrestrial (USFWS, 1991)

**Habitat Vegetation or Surface Water Classification**

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

**Geographic or Habitat Restraints or Barriers**

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

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

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

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2023)

**Number of Populations:**

62 (USFWS, 2023)

**Population Narrative:**

Since the 2010 status review, VDCR-DNH conducted shale barren rock cress surveys in 2013 (Van Alstine and Heffernan 2013, entire), 2017 (Van Alstine 2017, entire), 2018 (Van Alstine 2019, entire), 2019 (Stanley 2019, entire), and 2020 (Stanley 2021, entire). At the time of the 2010 status review, more than half of the known occurrences in VA had not been revisited since the 1990s. As of this review, approximately 30 (of 34) previously known EOs in VA have been revisited/monitored, and several new EOs and SFs within existing EOs have been identified. Of the 30 EOs that were revisited, 4 were downranked, and the remainder had no change in rank. The four downrankings were a result of either finding lower numbers of SFs than previous counts or finding other site conditions or reproductive conditions that lowered the EO rank. For this status review, VDCR-DNH staff botanist John Townsend reviewed the VA reports written since the 2010 status review to clarify the findings in terms of EOs and SFs. A total of 3 new EOs (comprising a total of 7 new SFs) were recorded during the 2017-2020 surveys, as well as a total of 31 new SFs that were grouped into existing EOs due to proximity to known SFs (J. Townsend, VDCR-DNH, email to S. Hoskin, Service, August 27, 2021). In 2011, WVDNR botanists reduced shale barren rock cress monitoring frequency to every 5 years due to concerns that shale barrens might be negatively impacted by people traversing the barrens during surveys. Depending on funding and staffing, EOs are monitored every 5 years. In 2017, WVDNR botanists clarified that a plant identified as shale barren rock cress was smooth rock cress (Arabis laevigata var. burkii) (WVDNR 2018, unpaginated). In 2019, WVDNR staff assisted in investigating a report of a new occurrence of shale barren rock cress in the path of a proposed Federal highway. After examining seeds under a dissecting microscope, sharing plant photos and a summary of characteristics with experts in VA and WV, and examining known shale barren rock cress plants, they determined the plants in question were a different species (WVDNR 2019). Overall, the status and trends in WV have been stable, but many of the EOs have fair or worse viability, which increases their risk to stochastic events (A. Silvis, WVDNR, letter to S. Hoskin, Service, January 25, 2021). In summary, the number of known EOs throughout the species range has increased from 34 to 62 in the 34 years since the time of listing, with 1 EO in WV not relocated and 4 EOs in VA not revisited since the 1990s. Twenty-nine EOs in VA and 22 EOs in WV have been assessed since 2010. Of these 51 EOs, 4 have been downranked and 47 have had no change in status since their original discovery (USFWS, 2023).

***Threats and Stressors***

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

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

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

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

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

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

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

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

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

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

***Recovery***

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

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

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

Recovery Priority Number: 11

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

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

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

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

**Recovery Actions:**

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

***Conservation Measures and Best Management Practices:***

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

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

***Species Taxonomic and Listing Information***

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

**Physical Description**

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

**Taxonomy**

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

**Current Range**

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

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

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

**Breeding Season**

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

**Key Resources Needed for Breeding**

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

**Reproduction Narrative**

Adult: The abundant white flowers that bloom mid-April through May are showy next to the red soils in which the plant grows. Seeds are dispersed by ants. (NatureServe, 2015). The dwarf bear-poppy is pollinated by many native bees and the non-native European and Africanized honeybee (Apis mellifera). Floral visitors have included at least nineteen different species from six families (Tepedino et al. 2014). Pollinator diversity has declined over the past decade with the loss of two specialist pollinators, the native solitary bees, Perdita meconis and Eucera quadricincta (Tepedino et al. 2014). The loss of specialist pollinators may be the result of the recent invasion of Africanized honeybees to Washington County, Utah (Portman et al. 2017, 2018; Tripodi et al. 2019). One of the primary pollinators is now the Africanized honeybee which appears to be adequately meeting the dwarf bear-poppy's pollination needs in recent years, but the long-term stability of this new mutualism is not yet known (USFWS, 2022).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Desert (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

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

**Environmental Specificity**

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

**Dependency on Other Individuals or Species for Habitat**

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

**Habitat Narrative**

Adult: Dwarf bear-poppy habitat is sparsely vegetated, and consists of highly weathered rounded hill and dome formations. Roughly half of the soil surface is bare of vegetation, and the majority of the living cover in the habitat is biological soil crust1 (Nelson 1989a; Nelson and Harper 1991; Simpson 2014). Associated native plants include shadscale (Atriplex confertifolia), Torrey's ephedera (Ephedra torreyana), nodding buckwheat (Eriogonum cernum), desert trumpet (E. inflatum), desert pepperweed (Lepidium fremontii) and burrobush (Ambrosia salsola). Invasive species include red brome (Bromus rubens), cheatgrass (Bromus tectorum), barb-wire Russian thistle (Salsola paulsenii), and African mustard (Malcomia africana) (Harper and Van Buren 2004; Simpson 2014). (USFWS, 2016); Dwarf bear-poppy is found on gypsiferous clay soils derived from the Moenkopi Formation, sometimes on cryptogamic crust. Occurs on rolling low hills and ridge tops, often on barren, open sites in warm desert shrub communities. Found at elevations between 700 and 1402 m. The dwarf bear-poppy grows sympatrically with the Moenkopi endemic Eriogonum thompsonae var. albiflorum. (USFWS, 1985; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

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

***Population Information and Trends***

**Population Trends:**

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

**Number of Populations:**

9 (USFWS, 2022)

**Population Size:**

We now cautiously estimate that 25,129 adult plants occur range-wide, with 71 percent occurring in the two largest fully censused populations, White Dome and Webb Hill (USFWS, 2022)

**Population Narrative:**

Because of its restricted habitat, it probably never was common. Population numbers fluctuate widely from year to year, based on precipitation, and a large seed bank with long lived seeds is a requirement for the maintenance of this species (Harper and Van Buren 2004). Short-term population trends indicate a decline of 10 to 30%. (NatureServe, 2015). We now know of nine dwarf bear-poppy populations on Federal (Bureau of Land Management (BLM)), Tribal, State of Utah, and private lands (Table 1). We re-evaluated and merged the original 11 population boundaries into seven populations using Nature Serve criteria (Nature Serve 2020). Two additional populations (Warner Valley Springs and Purgatory Flats) were discovered since 2009 (Washington County Water Conservancy District 2009; USFWS 2019). In our last status review, we reported the acreage of suitable habitat because comprehensive survey and census information was not available (USFWS 2016a). We now cautiously estimate that 25,129 adult plants occur range-wide, with 71 percent occurring in the two largest fully censused populations, White Dome and Webb Hill (Table 1). This population estimate is based on a recent census of five populations (Webb Hill, White Dome, Beehive Dome, Shinob Kibe, and Val Springs) using drone (unmanned aerial vehicle) imagery, a partial survey of the Red Bluffs population using drones, and recent site visits to two populations (Warner Valley Springs, Purgatory Flats). Census surveys were timed to occur during peak detection years following recruitment events. The uncertainty of our total population estimate is associated with the large, annual fluctuations in plant abundance, the low detectability in average or poor detection years when the species resides as a dormant seedbank, the low detection of seedlings from drone imagery, and lack of a complete census at the Red Bluffs and North Warner Ridge populations. We will update our range-wide estimate as new drone census data become available for the Red Bluffs and North Warner Ridge populations. (USFWS, 2022).

***Threats and Stressors***

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

**Stressor:** Land development (including residential and industrial development, utility projects, and road development) (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Potential impacts to dwarf bear-poppy from land development include mortality of individuals, habitat loss, degradation and fragmentation, increased soil erosion, increased dust generation, reductions in pollinator populations, reductions in plant reproductive potential, reductions in seed bank quantity and quality, and increasing invasive plant occurrences (Brock and Green 2003). (USFWS, 2016)
**Narrative:** Land development was considered a threat to dwarf bear-poppy at the time of listing (USFWS 1979). All known populations occur in Washington County, UT, in and around the city of St. George, which is currently one of the fastest growing metro areas in the country (U.S. Census Bureau 2000, 2010, 2014). Projections indicate that the population of Washington County will likely increase by 243 percent by the year 2050 from recorded 2010 levels (Utah Foundation 2014). Todate approximately 50 percent of the dwarf bear-poppy's historic habitat has been lost to urbanization and degradation from off-road vehicles (Harper and Van Buren pers. comm. 2004). Currently, the poppy no longer occurs on private lands in Washington County except for

habitat protected by The Nature Conservancy (TNC) (TNC 2015). Roughly 22 percent of known poppy habitat remains under state ownership by Utah School and Institutional Trust Lands Administration (SITLA). The loss of poppy habitat is highly likely in the next twenty years on the majority of State lands. A priority for recovery is the protection of poppy habitat on State and private lands. Protection options include land exchanges between the BLM and the State of Utah, land acquisition by TNC, a conservation agreement with the State of Utah, or additional protections afforded by the State of Utah and private landowners. Due to the high exposure and intensity of development in and around dwarf bearpoppy habitat, the continued and increasing levels of development in Washington County and around St. George, and the severity of the direct and indirect impacts to the species resulting from development, we assign development a high threat level for dwarf bear-poppy. (USFWS, 2016)

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

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

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the absence of the Act's protection, we believe the existing regulatory mechanisms would not provide dwarf bear-poppy with adequate protection from threats. Under the Act's protection, a review of Federal actions potentially impacting the species can be performed. Because the species occurs on Federal land, threats to the species can be addressed by regulatory mechanisms, and some threats (development, recreation) have been addressed. Enforcement of unauthorized recreation is not being addressed on Federal land, but that is not a result of lacking regulatory mechanisms. A newly identified threat to the species, the loss of specialist pollinators, is also not being addressed on Federal land but we need more information

about this threat in order to identify adequate regulatory mechanisms. There are no regulatory mechanisms on State and private lands to protect the species from these threats. We assign an overall threat level of high because development and recreation are high threats to the species and are not adequately being addressed by existing State regulatory mechanisms. (USFWS, 2016)

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

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 5C

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- 1. Protect occupied and suitable habitat from urban development. (USFWS, 2016)
- 2. Protect occupied and suitable habitat from degradation and additional fragmentation. (USFWS, 2016)
- 3. Support and monitor pollinators in occupied and suitable habitat as well as in adjacent habitat. (USFWS, 2016)
- 4. Perform research on suitable microsites for seedling establishment. (USFWS, 2016)
- 5. Perform propagation research using seeds and plant tissue. (USFWS, 2016)
- 6. Perform a comprehensive census of the medium and large dwarf bear-poppy populations (Red Bluff, Warner Ridge, Webb Hill, White Dome, and Beehive Dome). (USFWS, 2016)
- 7. Update the Recovery Plan. (USFWS, 2016)
- 8. Conduct Census and Monitoring Studies:Comprehensively census all known populations on a regular basis in order to produce an accurate picture of population number and

distribution to adequately characterize the species' status. In addition to the populations identified in #6, above: a) Locate and survey the Warner Valley Springs population on foot. b) Survey the Shinob Kibe population on foot. c) Based on census results, develop and implement a range-wide monitoring plan to determine population trends and select monitoring plot locations to regularly monitor recruitment, plant reproduction, and pollinator assemblage. Evaluate population breeding system. d) Monitor crust recovery of land scars periodically. BLM and TNC assistance with this action is essential. e) Regularly monitor and assess recreational use within plant populations. BLM, TNC, and State assistance with this action is essential. (USFWS, 2016)

- 9. Abate Heavy Land Use:a) Identify with GIS all land scars and degradation of habitat within populations and evaluate every 5 years. BLM and State assistance with this action is essential. b) Utilize technical expertise (USGS Las Vegas and Moab or universities) for habitat restoration, trail planning, and assessment of vehicular routes including mountain bikes trails in dwarf bear-poppy habitat. c) Assess and if necessary remove or redirect activities that negatively impact dwarf bear-poppy habitat. d) The Service should be a cooperator on the Washington County Comprehensive Travel and Transportation Management Plan. e) Update ACEC management prescriptions at Red Bluff and Warner Ridge/Fort Pierce to reflect current levels of impact on dwarf bear-poppy: Provide regular, adequate, and responsive monitoring and management at ACECs; Update Implementation Schedule of needed activities; Update ACEC Activity Plans. f) Provide ACEC management protections for the remaining dwarf bear-poppy populations on BLM lands. g) Provide consistent, scientifically based, range-wide management plans for the species. h) Engage and educate recreational user groups that are creating heavy use impacts. (USFWS, 2016)
- 10. Provide Adequate Law Enforcement to address unauthorized recreation use: a) Support law enforcement officials in promoting compliance with off-highway vehicle laws (and regulations) and effective deterrents of abuses of public land. b) Increase patrol of BLM lands to reduce non-compliant land use. c) Seek support and help from the Cities of St. George, Santa Clara, and Washington to manage use within poppy habitat. d) Prioritize and schedule regular land use patrol at high use areas (suggested Red Bluff near Bloomington, Red Bluff near Boomer Hill, Webb Hills at Brigham Road, White Dome at River Run Road, and North Warner Ridge). (USFWS, 2016)
- 11. Conduct Research to Better Understand Species and Species Response to Stressors and Threats: a) Repeat Population Viability modeling using new census and monitoring data on a regular basis. b) Evaluate the synergistic effect or feedback of multiple threats and stressors on the landscape and design a mitigation strategy to prevent extinction. c) Evaluate and implement a human-assisted gene flow pilot study. d) Evaluate and implement a pollinator rearing or transplant pilot study. (USFWS, 2016)
- 12. Coordinate with State, County, City Officials and Developers: a) Coordinate advance planning of development and infrastructure to avoid, minimize, and mitigate impacts to dwarf bear-poppy habitat. Conservation measures include permanent habitat protections with pollinator buffers to offset impacts, and seed and soil salvage operations to preserve the seedbank and genetic diversity when habitat is lost. b) Evaluate, address and offset habitat impacts from increased land use due to easier access provided by highways. (USFWS, 2016)
- Conservation measures are not available.

***Conservation Measures and Best Management Practices:***

- Recommended future actions: Based on recent discussions with conservation partners, we recommend the following future actions: 1. Work with partners to protect as much occupied and potential habitat as possible and improve habitat conditions for plants and pollinators by providing intact or restored habitat conditions, nesting sites and additional pollen and nectar sources; 2. Work with partners to restrict recreational use and restore degraded habitat areas to support the species and its pollinators in the Red Bluffs, Webb Hill, White Dome, and Shinob Kibe populations; 3. Work with partners to collect seeds prior to development and periodically from all populations to provide a genetically representative, off-site seed collection; 4. Continue range-wide monitoring efforts at the four populations (Red Bluffs (Tonaquint Block), White Dome, Beehive Dome, and Shinob Kibe) and expand to additional populations on protected lands; 5. Work with researchers to develop a fine-scale species distribution model using census imagery to identify favorable seedling microsites for seed additions and support future population augmentation efforts on BLM and TNC lands; 6. Work with partners and researchers to perform pilot seedings on BLM and TNC lands in favorable seedling microsites; 7. Continue to investigate propagation methods for the species to reduce plant and population losses and preserve genetic diversity; and 8. Work with researchers to develop an annual detectability estimate for the species based on population monitoring data to calculate the percentage of the population above ground and detectible for section 7 consultation effects analyses and population estimates. (USFWS, 2022)

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# SPECIES ACCOUNT: *Arctostaphylos confertiflora* (Santa Rosa Island manzanita)

***Species Taxonomic and Listing Information***

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

**Physical Description**

aperennial shrub in the heath (Ericaceae) family that grows 0.1 to 2.0 meters (4 inches to 6.5 feet) high, sometimes reaching as high as 6 meters (20 feet) (Wells 1993; Parker and Vassey in titt. 1998) (Figure 7). Santa Rosa Island manzanita occurs in prostrate and upright forms, the former most likely due to climatic influences and herbivory (McMmnn 1951). The plant has smooth, dark red-purplebark and densely hairy-glandularbranchlets and flower stalks. The leaves are light green, round-ovatewith cupped margins. The flowers occur in dense clusters that mature into flattenedreddish-brownfruits (McMinn 1951). Another manzanita on Santa Rosa Island, Arctostapliytos tomentosa, has three subspecies. These are differentiated from A. confertflora and eachother by variously having long, stiffhairs or no glandularity(A. t. ssp. crustacea - long, nonglandular hairs; A. t. ssp. insuticola - pubescent, nonglandular hairs; A. t. ssp. subcordata - long, glandular hairs) (USFWS, 2000).

**Taxonomy**

Belongs to the heath family (Ericaceae) (USFWS, 2014). Santa Rosa Island manzanita was described as Arctostaphytos confertflora by Eastwood in 1934 from a collection made by Hoffinann 4 years earlier “in a sheltered dell south of Black Mountain” on Santa Rosa Island (Eastwood 1934). Munz (1958) published the new combination Arctostaphytos subcordata var. confertflora. However, in subsequent treatments of the genus, Wells (1968, 1993) has continued to use the original taxonomy (USFWS, 2000).

**Historical Range**

See current range.

**Current Range**

Known from three areas on Santa Rosa Island; the north-east side of Black Mountain (less than 300 plants) combined with the Torrey Pine vicinity (less than 100 plants), the canyons on the south-east side of the island (less than 1,000 plants), and in the vicinity of South Point (approximately 200 plants) (USFWS, 2000).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Possibly sexual and self-pollination, based on closely related species (USFWS, 2014)

**Lifespan**

Adult: 100+ years (USFWS, 2014)

**Key Resources Needed for Breeding**

Adult: Fire; insect pollinators, based on closely related species (USFWS, 2014)

**Reproduction Narrative**

Adult: It has lost this ability to resprout and, as such, reproduce only by seed (obligate seeder) (Tyler and Odion 1996). Obligate seeders produce seeds annually, and a small proportion of the seeds may germinate each year. Dormant seeds are long-lived and accumulate in leaf litter and soil over time creating a long-term seed bank. Often in chaparral, the trigger is a fire; although the Service does not know the exact germination triggers for A. confertiflora, there is no reason to think it is different for this species of Arctostaphylos. Pollination and seed production in Arctostaphylos confertiflora are not well understood. Researchers studying A. pringlei (a closely related obligate seeder) observed that the species was pollinated by solitary bees, bumblebees (Bombus spp.), and syrphid flies (family Syrphidae); and the heaviest visitation was from honey bees (Apis spp.). They also observed successful self-pollination in A. pringlei (Fulton and Carpenter 1979). Arctostaphylos confertiflora is a long-lived perennial (individuals of the species may live 100 years or longer (Schreiner et al. 2006; D. Rodriguez, NPS, in litt. 2013)). Recruitment has been nearly zero at all three population locations for as long as monitoring has occurred (USFWS, 2014).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Chaparral, mixed woodland, pine woodland (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Scattered (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Scattered on sedimentary substrates (shales, volcanoclastic sediments, and sandstone) in chaparral, mixed woodland, and pine woodland communities. Extant plants are mostly on very steep slopes (NatureServe, 2015). Arctostaphylos confertiflora occurs as a component of mixed chaparral, mixed woodland, and island pine (Pinus torreyana, P. muricata) woodland vegetation types (Service 2000) (USFWS, 2014).

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Possibly U. l. santarosae (inferred from USFWS, 2014)

**Dispersal/Migration Narrative**

Adult: The NPS has observed the Santa Rosa Island fox (Urocyon littoralis santarosae) consuming Arctostaphylos confertiflora seeds, although the seeds appear to pass through the fox digestive system intact (Rodriguez, in litt. 2007). Seed viability testing was conducted on seeds contained in island fox scat; results indicate that there was no loss of viability in these seeds compared to the viability of undigested seeds (Ransom Seed Lab 2007) (USFWS, 2014).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2014)

**Redundancy:**

There is a lack of redundancy for Santa Rosa Island manzanita because the species is likely restricted to a single island, and most of the individuals of the species are in the Black Mountain occurrence, with relatively small numbers of plants at South Point or Sierra Pablo. This has not changed since listing, and is unlikely to change. The restricted range and few occurrences, coupled with possibly depleted seed banks, means that stochastic extirpation of small populations leading to species extinction remains a threat (USFWS, 2024).

**Number of Populations:**

3 (USFWS, 2014)

**Population Size:**

6,500 - 8,500 (USFWS, 2014)

**Adaptability:**

Low (inferred from USFWS, 2014)

**Population Narrative:**

It is found in only three populations. It is not possible to determine population trends (based on recruitment and mortality rates) at this time for Arctostaphylos confertiflora. There are 6,500 to 8,500 individuals on Santa Rosa Island (USFWS, 2014).

***Threats and Stressors***

**Stressor:** Erosion (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The listing rule for Arctostaphylos confertiflora identified soil loss (via erosion) and habitat alteration by non-native mammal species as Factor A threats to the species. All non-native ungulates excepting a few deer were removed from Santa Rosa Island in 2011 (Rodriguez pers. comm. 2012), and direct habitat destruction and curtailment by these animals is no longer a threat. However, because the ungulates were removed only recently, their impacts on A. confertiflora have not yet been reversed. Remaining indirect effects of ungulates on A. confertiflora habitat include edge effects from game trails, as well as wind and water erosion continuing to affect the seed bank, seed bed, and leaf litter. Although small increases in litter cover have occurred in some areas since monitoring started in 2001 (Schreiner et al. 2006), the

ground underneath arborescent A. confertiflora individuals is exposed and accumulated leaf litter tends to be removed by wind (Rodriguez pers. comm. 2012) (USFWS, 2014).

**Stressor:** Insect damage (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 2007 5-year review reported insect damage to individuals of Arctostaphylos confertiflora in all three populations. Damage included fruit and seed predation (Rodriguez, pers. comm. 2006a, 2012) and leaf damage (Dale-Cesmat, in litt. 2005; Rodriguez, pers. comm. 2006b, 2012). The NPS correlated apparently higher levels of “die-back” with insect damage at Black Mountain (Rodriguez, in litt. 2006c). In late 2007, the NPS and USGS observed defoliation of A. confertiflora individuals by tussock moth caterpillars. In the following spring, at least seven individuals appeared to have died as a result (McEachern and Rodriguez 2008). The individual plants killed by the moths were already stressed by other factors, and it is likely that healthy A. confertiflora would be resilient to defoliation by tussock moths (Rodriguez pers. comm. 2012). Tussock moths appear on A. confertiflora in an irregular, multi-annual cycle. The Service is uncertain regarding the extent to which insect damage represents a threat to the species; however, tussock moths can rapidly defoliate plants (Brubaker 1978, Harrison and Maron 1995) and could pose a threat to species such as A. confertiflora that have a restricted range and low reproductive success (USFWS, 2014).

**Stressor:** Low reproductive success (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In some locations, the past browsing pressure resulted in plants that never had the opportunity to fruit, flower, and produce seed. In other locations, plants had become arborescent through browsing of the lower portions of the plant; in this case, even if the plants produced seed, the increased erosion under and around stands did not provide suitable conditions for seed retention and germination. These effects compromised the seed bank and reduced the quality of germination sites. The Ransom Seed Lab (2007) found that the germination rate during standard lab testing was zero. These results are not uncommon for Arctostaphylos species (Rodriguez pers. comm. 2012), because members of this genus typically require a specific trigger (such as scarification from a fire event) to break seed dormancy and allow germination to occur (USFWS, 2014).

**Stressor:** Stochastic events (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although the extant populations of Arctostaphylos confertiflora are not particularly small, there are only three. Rarity, including a small number of populations, makes a species vulnerable to stochastic events. Arctostaphylos confertiflora is a long-lived species and there are 6,500 to 8,500 individuals on Santa Rosa Island. Therefore, most natural stochastic events are unlikely to extirpate all three populations. One exception is fire. Although the species is an obligate seeder and likely requires fire for large-scale germination, mature plants of this species do not regenerate when damaged by fire as do burl-forming species of Arctostaphylos. In

addition, the species' depleted seed bank may preclude large-scale germination required to replace destroyed mature plants. Therefore, a large enough fire could extirpate one or more of the three known A. confertiflora populations (USFWS, 2014).

**Stressor:** Climate change (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, increased summer continental drying, and increased fire frequency (Field et al. 1999; Cayan et al. 2005; Westerling et al. 2006; IPCC 2007). Increased fire frequency could have positive or negative impacts on Arctostaphylos confertiflora. Recently, Loarie et al. (2008) modeled the potential impacts of climate change on the flora of California. They predicted that species' distributions will shift in response to climate-driven habitat changes. Specifically, they predicted that, in general, species will shift northward and to higher elevations, and may experience a reduction in the extent of available habitat. Species will redistribute with shifting habitat, depending on the ability of each species to do so. Species diversity will also shift with a general trend of diversity increasing towards the coast and northwards, with these areas becoming de facto future refugia. Given the narrow geographic range of A. confertiflora, the species will have limited ability to disperse in response to climate change (USFWS, 2014).

***Recovery***

**Reclassification Criteria:**
Maintain three stable or increasing populations on Santa Rosa Island with evidence of natural recruitment for a 30-year period including the normal precipitation cycle (USFWS, 2000).

Recovery Priority Number: 2

Other Actions 2. Seed stored in CPC (Center for Plant Conservation) cooperating facilities. • Seeds banked for conservation are from relatively few maternal individuals and not all populations are represented. Conservation seed banks are not funded in perpetuity. This criterion has not been met. 3. Seed germination, propagation techniques, and fire ecology understood. • There have been studies of the soil seed bank and seed germination, and there has also been propagation from cuttings and then successful outplanting both seed and cutting derived plants. This criterion has been met. 4. Natural seed bank developed and maintained. • Soils continue to improve following ungulate removal. There is evidence that the soil seed bank is increasing, and natural seedlings are becoming more frequent, also indicating the presence and function of a soil seedbank. However, both the soil seed bank and numbers of seedlings have not been rigorously documented. The status of this criterion is uncertain. 5. Fire management plan developed. • CINP completed a draft fire management plant (CINP 2023). The plan recognizes that threatened and endangered species need to be protected from adverse effects of wildfire (p. 17). This criterion has been met. 6. Protected from browsing to allow reproduction. • No non-native ungulates remain on Santa Rosa Island. This criterion has been met. 7. Life history research conducted and incorporated into recovery criteria. • Many facets of the species biology, including reproductive output, the soil seed bank, seed viability, seed germination, and seedling requirements have been investigated. This criterion has largely been met. 8. If declining, determine cause and reverse trend. • While the natural populations appear to be stable or increasing, because of infrequent censuses and irregular monitoring this is not well documented. A robust census and population monitoring protocol needs to be developed. This criterion has not been adequately met (USFWS, 2024).

**Delisting Criteria:**
1. No decline in populations for 10 years after downlisting (USFWS, 2000).

2. All potential habitat surveyed. Santa Rosa Island has been extensively surveyed during vegetation surveys (Reyes et al. 2017 entire), and the distribution of the species on Santa Rosa Island is well understood. This criterion has been met. (USFWS, 2021)

**Recovery Actions:**
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).
- The Service recommends that the NPS conduct a threats assessment for insect damage to Arctostaphylos confertiflora. If the assessment indicates insect damage is a concern, the NPS could consider a trial insect control program and additional monitoring to track the extent of insect damage (USFWS, 2014).
- Arctostaphylos confertiflora seeds may require episodic disturbances to stimulate seed germination. These conditions are critical for the establishment and survival of new generations and recovery of the species. Additional research should be done to identify germination cues using methods that are more appropriate for fire-adapted seeds. Once germination cues are better understood, the NPS could explore ways to enhance these conditions in the field through activities such as controlled burns and erosion control (USFWS, 2014).
- Because this species is an obligate seeder and regeneration is sporadic without the presence of disturbance such as fire, an important measure of recovery is the size and viability of the seed bank. The seed bank should be monitored at regular intervals (such as every 3 years) by surveying the amount of seeds in the soil seed bank and conducting seed viability analysis on the seed samples collected during the surveys (USFWS, 2014).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Develop a monitoring plan to track population sizes and distribution. 2. Bolster conservation seed banks with additional maternal lines from all populations. 3. Research seed germination and seedling recruitment requirements. 4. Monitor soil seed bank seed abundance, and develop methods to enhance the soil seed bank. (USFWS, 2021)
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Develop census and monitoring plans to better track occurrence sizes and of Santa Rosa Island manzanita, especially of seedlings. 2. Continue to develop methods to assess and enhance the soil seed bank. 3. Continue research on seed germination and seedling recruitment requirements, particularly under natural conditions. 4. Bolster conservation seed banks with additional maternal lines from all occurrences. 5. Search the Dick's Harbor area on Santa Cruz Island for the species (USFWS, 2024).

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USFWS 2014. Arctostaphylos confertiflora (Santa Rosa Island Manzanita) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California. There is a lack of redundancy for Santa Rosa Island manzanita because the species is likely restricted to a single island, and most of the individuals of the species are in the Black Mountain occurrence, with relatively small numbers of plants at South Point or Sierra Pablo. This has not changed since listing, and is unlikely to change. The restricted range and few occurrences, coupled with possibly depleted seed banks, means that stochastic extirpation of small populations leading to species extinction remains a threat.

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# SPECIES ACCOUNT: *Arctostaphylos glandulosa ssp. crassifolia* (Del Mar manzanita)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/7/1996; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A perennial burl-forming shrub; plant height ranges from 1 to 1.2 meters (3.3 to 4 feet) tall. It has thick, leathery leaves that are dark grey-green and a characteristic smooth red bark. It has clusters of urn-shaped flowers (white to pink). The twigs and young stems characteristically lack glandular hairs, but rather are either densely covered with short fine hairs or have scattered longer hairs. The leaves are dark grey-green, sometimes with a reddish margin. The flowers are small, urn-shaped, white to pink in color, and appear between late winter and early spring. Compared to other subspecies, the globose fruits are small and markedly depressed and the twigs lack glandular hairs. The fruits of A. glandulosa produce an average of six seeds embedded in a hard resinous endocarp surrounded by a pulpy pericarp (USFWS, 2010).

**Taxonomy**

A member of the Ericaceae (heath family). In a recent taxonomic treatment for the species A. glandulosa, a new, narrower distribution for A. g. subsp. crassifolia was proposed. Based on morphologic traits, researchers restricted the distribution to within 3, or possibly 6 miles (mi) (5 to 10 kilometers (km)) from the coast, from Encinitas in San Diego County, south to Baja California (Keeley et al. 2007, p. 57). Carlsbad was not included in this distribution because the research suggests that while some of the plants in Carlsbad are A. g. subsp. crassifolia, many are a different subspecies (A. g. subsp. glandulosa) and that these northern populations comprise a mixture of the two subspecies (Keeley et al. 2007, p. 57). Based on this new treatment, surveys for A. g. subsp. crassifolia by land managers at the Rancho La Costa Habitat Conservation Area in Carlsbad, yielded nine individuals in a population previously thought to be over 1000. The majority of the plants at this site are now considered A. g. subsp. glandulosa (CNLM, unpubl. data 2009) (USFWS, 2010). Also known as Eastwood's Manzanita (NatureServe, 2015).

**Historical Range**

Historically, Arctostaphylos glandulosa subsp. crassifolia was believed to be restricted to sandstone terraces and bluffs along the immediate coast in San Diego County, California, from Carlsbad south to Torrey Pines State Reserve (USFWS, 2010).

**Current Range**

Endemic to San Diego County, California and northwestern Baja California, Mexico (USFWS, 2010).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Vegetative, sexual (USFWS, 2010)

**Breeding Season**

Adult: December - April (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, fire (USFWS, 2010)

**Reproduction Narrative**

Adult: Blooms December-April (NatureServe, 2015). The fruits of A. glandulosa produce an average of six seeds. The flowers of Arctostaphylos glandulosa are self-incompatible and are visited by flies, bees, and bee-flies (Keeley 1977, p. 821; Moldenke 1976, pp. 318-353). Arctostaphylos glandulosa seeds are dependent on fire to germinate. Typically, seedlings are only established in the first year after a fire (Keeley 1991, p. 96). Arctostaphylos glandulosa subsp. crassifolia plants are woody shrubs, which, when mature, can regenerate from burls (lignotubers) and from seeds. The burl at the base of the stem is covered with undeveloped branch buds. Typically, these buds will sprout after the stems are removed or damaged by fire or other means. Occasionally some of these buds will sprout in the absence of fire (Keeley 1992a, p. 1196) (USFWS, 2010).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Maritime chaparral (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Coastal fog (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs < 100 m elevation (NatureServe, 2015); canopy-forming vegetation - shade intolerant; generally occurs within 5 mi of the coast (USFWS, 2010)

**Spatial Arrangements of the Population**

Adult: Linear (inferred from USFWS, 2010)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Sandstone terraces and bluffs at < 100 m elevation in low, fairly open southern maritime chaparral communities. (NatureServe, 2015). A. glandulosa is shade intolerant and can be replaced by taller stature species (Howard 1992, p. 5). Southern maritime chaparral can be described as a chamise-black sage chaparral that includes rare species such as A. g. subsp. crassifolia and is associated with coastal fog from Carlsbad south to Point Loma. It occurs on weathered sandstone soils including the Carlsbad series, Cesterton series, and Corralitos sandy loam. It can also be found on loamy alluvium, rough broken land, and terrace escarpments. Southern maritime chaparral is typically found within 5 mi (8 km) of the coast (USFWS, 2010).

### *Dispersal/Migration*

**Dispersal**

Adult: Low to moderate (USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: There does not appear to be any specialized seed dispersal mechanism and the fruits generally fall close to the parent plant in late summer where they may be consumed by rodents (Keeley 1977, pp. 821-826). Some are eaten by foxes or coyotes and may be transported some distance away (Keeley 1977, p. 826; J. Keeley, U.S. Geological Survey, pers. comm. 2009) (USFWS, 2010).

### *Population Information and Trends*

**Population Trends:**

Not available

**Number of Populations:**

56 Extant EO's (USFWS, 2023)

**Population Narrative:**

At the time of the 2010 5-year review for Arctostaphylos glandulosa subsp. crassifolia, there were 51 known occurrences [including 1 relocation and restoration site (EO 15) and 1 transplanted occurrence at San Diego Botanic Garden in Encinitas, California (EO 59)] that were extant or presumed extant (Service 2010, pp. 5, 7) (Appendix A). Six of the 51 occurrences were yet to be included as Element Occurrences (EO) in CNDDB, the database maintained by California Department of Fish and Wildlife (CDFW) (Appendix A). Since then, all occurrences identified in the 2010 5-year review have been assigned EO numbers in CNDDB, EO 53 was subsumed into the nearby EO 47, and 6 new EOs (EOs 61–62, 65–67, and 73; Figure 1; Table 1) have been described (CDFW 2023, database). Thus, there are 56 extant (or presumed extant) EOs that are currently known (CDFW 2023, database). However, the subspecies identity of plants at inland locations such as MCAS Miramar has been questioned; some experts have suggested that plants at these locations are hybrids or belong to a different subspecies of A. glandulosa (USFWS, 2023).

### *Threats and Stressors*

**Stressor:** Development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** According to the listing rule, the majority of extant populations had been greatly reduced and significantly fragmented due to urban and agricultural development mostly prior to listing (USFWS 1996, p. 52378). The majority of these populations were distributed in highly fragmented habitat along the margins of residential development. At listing, four of the six

largest populations were threatened by proposed or approved development projects. Since listing, completion of these projects resulted in an additional 35 percent being eliminated through direct impacts and 20 percent through indirect impacts to these four populations. In addition, several of the smaller populations were impacted by development (USFWS 1996, pp. 52377- 52378). Impacts of development are rangewide (USFWS, 2010).

**Stressor:** Fire management (USFWS, 2010).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fuel modification activities can result in the damaging or removal of plants and their habitats. In addition, these activities can increase the fragmentation of habitat and increase the rate and extent of introduction of nonnative species which could in turn increase both erosion and fire frequency, all of which pose threats to A. g. subsp. crassifolia (see discussion of nonnatives and altered fire regime below) (Longcore 2003, p. 116). Fire history data shows that the majority of Arctostaphylos glandulosa subsp. crassifolia occurrences (mainly located directly adjacent to residential development) have not burned in the last 100 years. Fire suppression activities may have prevented these areas from burning given their proximity to residential development, however, their proximity to residential development also puts them more at risk to be subjected to fire. Given this last assumption, the Service believes that fire suppression activities alone in the order of 100 years may not pose a threat to the habitat of A. g. subsp. crassifolia. However, more information is needed to determine what, if any, the impacts are of fire suppression in cycles greater than 100 years. Fires that occur too frequently may threaten the species because if resprouting plants are burned again before they are able to adequately replenish stores in the burls or sufficient seeds for their seed bank leaving the long term persistence of the plants in doubt. When fires are too frequent, nonnatives (especially grasses) can invade frequently burned areas and outcompete natives. In addition, they can modify the environment in their favor by creating a mass of highly flammable fuels which not only can extend the length of the fire season, but alter the types of fires that occur (USFWS, 2010).

**Stressor:** Invasive species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some invasive nonnative plants can become well established locally and may have profound impacts to the habitat. For example, land managers at the Rancho La Costa Habitat Conservation Area (EO 1) in the City of Carlsbad have noted a nonnative grass, Ehrharta calycina, as a serious problem for the reserve (Appendix 1). This grass is invasive, can cover the ground like a mat, and potentially increase the flammability of the area (J. Vinje, CNLM, pers. comm. 2009). According to the California Invasive Plant Inventory, Ehrharta calycina is considered to have a severe ecological impact on plant and animal communities and are considered to be severely invasive (Cal-IPC 2006, pp. 3-11). Another example is the presence of a woodland Eucalyptus spp. at San Dieguito County Park (EO 17). The canopy is relatively open over the Arctostaphylos glandulosa subsp. crassifolia occurrence but there is a layer of dead, high oil content leaves augmented by park personnel who spread additional leaf litter and wood chips from maintenance operations in the area (Luciani, pers. obs. 2009). If, and when a fire starts at this site, it will likely be intense enough to kill at least some of the burls. In addition, Eucalyptus spp. can have an allelopathic effect on other plants from the compounds found in its bark and leaf

litter. These compounds have been shown to inhibit germination, seedling length, vigor, and nitrogen fixation of certain plant species (Sasikumar et al. 2001, pp. 135-137). Currently, nonnative species likely continue to be a threat to A. g. subsp. crassifolia and its habitat at most occurrences (USFWS, 2010).

**Stressor:** Residential development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Most A. g. subsp. crassifolia occurrences are directly adjacent to residential development. Use of these lands, whether or not public access is allowed, has proven to be problematic. For example, unwanted public use of lands supporting A. g. subsp. crassifolia have resulted in trail creation, disposal of green waste, dumping of trash, vandalism, and itinerant encampments on the Kelly Ranch and Rancho La Costa Preserves in the City of Carlsbad (CNLM 2008a, p. 22; CNML 2008b, p. 28). The Service has no evidence of direct impacts to A. g. subsp. glandulosa or its habitat; however, these activities generally lead to habitat degradation (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some of the occurrences of Arctostaphylos glandulosa subsp. crassifolia are potentially threatened by having a small population size. The listing rule estimated a 50 percent decline in the number of stands and individuals since 1982. In addition, the rule stated that over 75 percent of the remaining individuals occurred at 6 of the 25 locations. Four of those populations have been further reduced by development. At one occurrence (the portion of EO 1 at the Rancho La Costa Habitat Conservation Area) there are only nine individuals of A. g. subsp. crassifolia. A commonly accepted principal in conservation biology is that small populations have higher probabilities of extinction than larger populations. Populations with small numbers of individuals are more susceptible to genetic drift, losing variation more readily making them more prone to local extinction. In addition, species whose numbers have been significantly reduced due to habitat destruction may be more susceptible to genetic stresses imposed by small population size (Barrett and Kohn 1991, p. 7). Other factors that can make small populations more susceptible to extinctions than large populations are demographic stochasticity and naturally occurring events such as wildfires, floods, droughts, and disease (Shaffer 1981, p. 131). Because the majority of A. g. subsp. crassifolia occurrences are small, it is reasonable to consider these smaller populations at risk due to these effects of small population size (USFWS, 2010).

**Stressor:** Military training (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, populations of A. g. subsp. crassifolia have been found on MCAS Miramar (EO 47, 50, 51, 52, 54, 55, and MCAS Miramar training areas). Potential threats to the plant on MCAS Miramar range from ground training activities including foot traffic, motor vehicle operations, combat engineering support operations, temporary encampments, and fixed or rotary wing aviation operations (MCAS Miramar 2006, p. 2-6). Impacts from these training

activities can result in trampling and destruction of seedlings and plants. However, threats associated with these training activities are thought to be minimal and potentially offset by management considerations described in MCAS Miramar's INRMP (USFWS, 2010).

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, p. 1; Cayan et al. 2006, pp. 1, 7-8; IPCC 2007, pp. 8-9). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5 to 6° F (2.7 to 3.3° C) (Morse et al. 1995, p. 393). Whether or not this would include Arctostaphylos glandulosa subsp. crassifolia is unknown (USFWS, 2010).

**Stressor:** Herbivory and Disease (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While the health of the Arctostaphylos glandulosa subsp. crassifolia population in the MCAS Miramar post-fire monitoring plots has increased, surveyors also observed signs of herbivory and disease. While monitoring 253 tagged individuals, MCAS Miramar surveyors observed nectarrobbing (i.e., when insects access floral resources from the outside of the flower opening without touching the flowers anthers or stigma) on "many individuals," signs of insect herbivory of leaves on 14 percent of individuals, and black leaf spots (which could be a sign of sun damage or fungal growth) on 32 percent of individuals (Tetra Tech, Inc 2012, p. 15). The report recommended that disease and herbivory continue to be monitored to determine if these factors negatively impact A. g. subsp. crassifolia growth and reproduction over time (Tetra Tech, Inc 2012, p. 18). The Center for Natural Lands Management also mentioned disease as a potential threat to Arctostaphylos glandulosa subsp. crassifolia. In a letter to the U.S. Fish and Wildlife Service, the Center for Natural Lands Management stated that powdery mildew (Podosphaera xanthii), a fungal disease, had been observed affecting the leaves of A. g. subsp. crassifolia at preserves they managed in Carlsbad, California (Center for Natural Lands Management 2021, in litt., p. 2). In 2017, they initiated monitoring to determine presence of powdery mildew on A. g. subsp. crassifolia at the La Costa Glen Habitat Conservation Area, but did not find any (Center for Natural Lands Management 2021, in litt., p. 2–3). (USFWS, 2023)

**Stressor:** Hybridization (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A report from MCAS Miramar suggested that hybridization could be a threat to the subspecies, in addition to altered fire regime (including plant canopy encroachment), nonnative invasive plants, erosion with high rainfall events, nectar-robbing and herbivory, and potential

disease (USFWS, 2023)

***Recovery***

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

Recovery Priority Number: 6C

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

**Recovery Actions:**

- Not available - this species does not have a final recovery plan.
- Determine subspecific identity and densities of plants at occurrences peripheral to the core coastal portion of the range (USFWS, 2010).
- Assess the reproductive output of Arctostaphylos glandulosa subsp. crassifolia occurrences, including seed production and viability (USFWS, 2010).
- Determine causes and likely remedies for apparent low rate of establishment of new plants. This should include establishing the role of fire in the species biology and exploration of an acceptable alternative (USFWS, 2010).
- Evaluate the status of Arctostaphylos glandulosa subsp. crassifolia in Mexico (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will provide a better understanding of Arctostaphylos glandulosa subsp. crassifolia population health, reproductive output, and factors affecting the low rate of establishment. Additional genetic information will also help to better understand relatedness between the listed entity and the other six subspecies and provide more clarity of the geographic distribution of the listed entity. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Work with partners to identify opportunities for conservation or preservation of Arctostaphylos glandulosa subsp. crassifolia occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire A. g. subsp. crassifolia habitat. 2. Assess the taxonomic status of Arctostaphylos glandulosa subspecies (and similar species) in California and Mexico such that the endangered entity (A. g. subsp. crassifolia) can be clearly identified. a. Determine the geographic distribution of the endangered entity and hybridization zones. b. If necessary, revise circumscriptions for Arctostaphylos glandulosa subspecies and related taxa. 3. Evaluate the status of Arctostaphylos glandulosa subsp. crassifolia in Mexico. 4. Assess the reproductive output of Arctostaphylos glandulosa subsp. crassifolia occurrences, including seed production and viability. 5. Determine causes and likely remedies for apparent low rate of establishment of new plants. This should include establishing the role of fire in the subspecies’ biology and exploration of an acceptable alternative. 6. Determine the extent to which herbivory or disease may be affecting survival, reproduction, or recruitment of Arctostaphylos glandulosa subsp. crassifolia. (USFWS, 2023).

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# SPECIES ACCOUNT: *Arctostaphylos morroensis* (Morro manzanita)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 1/17/1995; Pacific Southwest (R8)

**Physical Description**

This shrub reaches a height of 1.5 to 4.0 meters (5 to 13 feet) and has crowded oblong to ovate grey-green to olive-green leaves, 2.5 to 4.0 centimeters (1 to 1.5 inches) long, with petioles 2 to 6 millimeters (0.08 to 0.20 inch) long. The white to pinkish flowers are 5 to 8 millimeters (0.2 to 0.3 inch) long, and form orange-brown fruits 8 to 13 millimeters (0.3 to 0.5 inch) in diameter with 8 to 10 stones per fruit that are fused but separable. The bark ofthe trunk is a shaggy grey to brown; the leafblades range from wedge-shaped (cuneate) to rounded ornearly straight (truncate) at the base, with the lower surface paler and usually somewhat tomentose (short woolly hairs). Occasional specimens have small projecting lobes at bases of the leaf blades and a short leafstalk or none at all (USFWS, 1998).

**Taxonomy**

Member of the heath (Ericaceae) family. Morro manzanita (Aretostaphylos morroensis) (Figure 3) was first described by Albert E. Wieslander and Beryl 0. Schreiber in 1939 (Wieslander and Schreiber 1939) based on a specimen collected in Hazard Canyon, south ofMorro Bay, which is now within the boundaries ofMontai'ia de Oro State Park. The species has continued to be recognized by McMmnn (1939), Abrams (1944), Munz(1959), Hoover (1970), and Wells (1993) (USFWS, 1998).

**Historical Range**

Endemic to San Luis Obispo County, California. The distribution of A. morroensis is correlated with the distribution of Baywood fine sands. Based on the distribution of these sands, the historical distribution of A. morroensis is estimated to have comprised between 2,000 and 2,700 acres (809 and 1,092 hectares (ha)) (USFWS, 2013).

**Current Range**

Arctostaphylos morroensis ranges from the northeast side of Morro Bay to the southern end of Montaña de Oro State Park, a distance of less than 10 miles (16.1 kilometers) (USFWS, 2013).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2013)

**Lifespan**

Adult: 47+ years (USFWS, 1998)

**Dependency on Other Individuals or Species**

Adult: Bombus vosnesenskii (USFWS, 2013)

**Breeding Season**

Adult: Winter (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, > 40 year fire intervals (USFWS, 2013)

**Reproduction Narrative**

Adult: Arctostaphylos morroensis flowers in the winter, with fruit maturation and seed dispersal occurring in the fall. Unlike other species of manzanita, A. morroensis is an obligate seeder, lacking a woody burl from which it can resprout post-fire. Fruits contain 8 to 10 seeds each. Although it is unknown whether the flowers are self-compatible, extensive research revealed that pollination is required for reproduction. In 1998 and 1999, Tyler and Odion found that bumblebees (Bombus vosnesenskii) are the dominant pollinators, though anthophorid bees (Anthophora urbana), several bee flies (Bombylius spp.), and syrphid flies (family Syrphidae) are also known pollinators. The authors also noted surprisingly low pollinator activity for both years surveyed (Tyler et al. 1998 and 2000). Only 10 percent of flowers examined in 1998 produced fruits. For Arctostaphylos morroensis and other obligate-seeding species of manzanita, maintenance and regeneration are dependent upon mass germination triggered by fire (Tyler and Odion 1996). Fire breaks seed dormancy and also creates open areas where seedlings can germinate and individuals establish. Due to very low seed viability in Arctostaphylos morroensis, in combination with high seed mortality in response to fire, Tyler and Odion (1996) suggest that stands burned at cycles greater than 40 years would have sufficient time to accumulate an adequate seed bank (USFWS, 2013). Morro manzanita is a long-lived shrub; studies of stand age based on trunk ring counts and aerial photos of previous disturbance events, including fire and possibly clearing, indicate that the youngest intact stands are some of those south of Highland Drive, which are about 37 years old. Stands west of Pecho Drive are about 47 years old. The remainder are older than 47 years, with stands in the Elfin forest estimated to be the oldest (Tyler and Odion 1996) (USFWS, 1998).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal dune scrub, maritime chaparral, coast live oak woodland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (USFWS, 2013; see reproduction narrative)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs < 200 m elevation (NatureServe, 2015); closed-canopy (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2013)

**Habitat Narrative**

Adult: Inhabits soils derived from ancient sand dunes. Found in nearly pure stands on steep slopes, especially on north exposures. On low-moderate slopes, found in association with coastal dune scrub, maritime chaparral, and coast live oak woodland communities; < 200 m elevation. (NatureServe, 2015). Development of climax, closed-canopy chaparral stands has an adverse effect on populations of A. morroensis by precluding expansion into otherwise suitable habitat. Arctostaphylos morroensis is primarily found on Baywood fine sand soils (ancient wind-blown beach sands), though small stands have also been documented on Santa Lucia shaley clay loam (Soil Conservation Service 1958, McGraw 2005) (USFWS, 2013).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: Birds and large mammals (coyote (Canis latrans) and mule deer (Odocoileus hemionus)) are thought to aid Arctostaphylos morroensis in seed dispersal (Keeley and Hays 1976). This secondary dispersal (which occurs after the parent plant initially sets seed) is limited, however, as evidenced by 90 percent fewer seeds present in soil cores 5 feet (1.5 meters) away from A. morroensis compared to samples taken from beneath the canopy (Tyler and Odion 1996) (USFWS, 2013).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Stable (inferred from USFWS, 2013)

**Number of Populations:**

18 (NatureServe, 2015); Unknown (USFWS, 2013)

**Population Size:**

Currently unknown; previously 86,500 - 153,000 (USFWS, 2013)

**Adaptability:**

Low (inferred from USFWS, 2013)

**Population Narrative:**

It is unknown precisely how many populations occur across the range of the species. LSA estimated approximately 153,000 Arctostaphylos morroensis plants occurred across the species' range at the time of listing. McGuire and Morey produced a lower estimate than LSA (using a 15-foot diameter per individual), estimating that the total species population would be closer to 86,500 individuals (McGuire and Morey 1992). An accurate estimate of Arctostaphylos morroensis abundance throughout its range was unavailable at the time of the 5 year review. Tyler and Odion (1996) hypothesized that the low viability may be due to inbreeding as a consequence of small effective population sizes. The current status of Arctostaphylos morroensis is not markedly different than what was summarized in the final listing rule published in 1994, the final recovery plan completed in 1998, or the most recent 5-year review, released in 2008 (USFWS, 2013). There are 18 occurrences (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Habitat destruction and alteration (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Areas of habitat with high cover of Arctostaphylos morroensis are still at risk on private lands that could be developed in the future. For example, in 2010, a privately owned parcel containing this species in Cabrillo Estates was developed for a private residence. The spread of nonnative species, particularly veldt grass, has altered the composition of the plant communities associated with Arctostaphylos morroensis habitat. This in turn is likely altering the fire cycle, potentially increasing the frequency of fires, and decreasing the viability of existing seed banks. the acquisition of lands reduces the threat of destruction of habitat from development. However, the continued spread of nonnative species throughout Arctostaphylos morroensis' range and the fire cycle needs particular to the species (discussed below in Factor E) necessitate land management that is not currently in place; alteration of habitat from nonnative species is increasing (USFWS, 2013).

**Stressor:** Altered fire cycles (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Land managers have not planned any prescribed burns for Arctostaphylos morroensis habitat. The U.S. Army Corps of Engineers burned and cleared shrubs in Montaña de Oro State Park in 1958; however, the Service has no knowledge or evidence of prior burns (Odion and Tyler 2003). Montaña de Oro State Park performs controlled burns as needed and when possible, but burning A. morroensis habitat is inhibited by the nature of the landscape. The fuel requirements, steepness of the slopes, limited accessibility, and proximity to residential areas make a prescribed burn for A. morroensis difficult to perform (V. Cicero, California State Parks, in litt. 2012)). The most recent wildfire within the State Park occurred in 1997, but did not burn A. morroensis stands. Wildfires for this maritime chaparral habitat are estimated to occur about every 50 to 200 years (Cicero in litt. 2012). For these reasons, the limited ability to manage fire cycles hinders efforts to reduce the threat of altered fire cycles to A. morroensis (USFWS, 2013).

**Stressor:** Invasive species (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The nonnative veldt grass (Ehrharta calycina) has spread to the Los Osos and Morro Bay region. This species has not only invaded disturbed areas, such as vacant lots, road cuts, and utility corridors, but is becoming naturalized in native plant communities, including conserved lands owned and/or managed by the CDFW and CDPR for Arctostaphylos morroensis (J. Vanderwier, U.S. Fish and Wildlife Service, pers. obs., 2006). Members and volunteers associated with Small Wilderness Area Preservation use manual removal to fight veldt grass in the Elfin

Forest and continue to make progress (Sarafian 2011). Although veldt grass more likely competes for resources with herbaceous species than with established perennials, its presence may also increase the frequency and risk of fire that would negatively affect A. morroensis by reducing the abundance and viability of its seed bank. Veldt grass is not currently invading established A. morroensis stands in Montaña de Oro State Park, although it may prevent recruitment in areas where it has already invaded the habitat (Cicero in litt. 2012). In the final listing rule, the Service recognized that stands of Arctostaphylos morroensis in Montaña de Oro State Park were being overtopped by spreading eucalyptus (Eucalyptus spp.) planted in the early 1900s. The Service noted that A. morroensis is not able to survive such encroachment due to reduction in available soil moisture, increased shading, and the effects of growth-inhibiting terpenes that are released from eucalyptus (California Invasive Plant Council 2006-2011). Although the general plan for Montaña de Oro State Park calls for the removal of exotic species, including eucalyptus, this program has only been partially implemented. In past years, eucalyptus removal efforts generally focused on removing seedlings from outside the bounds of the original groves and not specifically from habitat that supports A. morroensis (Service 1998). Recently, efforts to control eucalyptus have been undertaken and have been successful in preventing further recruitment. However, fluctuations in the park’s budget in coming years may hinder these efforts; therefore, the Service still considers competition with eucalyptus to be a threat (Cicero in litt. 2012). Other invasives not mentioned at the time of listing, including narrow-leafed iceplant (Conicosia pugioniformis), are encroaching upon Elfin Forest populations of Arctostaphylos morroensis. Bridal creeper (Asparagus asparagoides) is also posing a threat in the Elfin Forest (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). Arctostaphylos morroensis’ small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as those that may result from climate change. Recently, Loarie et al. (2008) discussed the potential impacts of climate change on the flora of California. Based on climate modeling, they predicted that species’ distributions will shift in response to climate change and that species will “move” to higher elevations and northward, depending on the ability of each species to do so. Broadly, indirect ecological impacts caused by fog and variation in humidity could alter pollinator activity, soil moisture, and phenology of the species. In general, the scientific community lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species. Small-ranged species, such as A. morroensis, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 8

**Delisting Criteria:**
1. Ninety percent of existing acreage supporting high (75-100 percent) and medium (25-75 percent) cover of Morro manzanita and 85-90 percent of low (1-24 percent) cover supporting Morro manzanita are secured from human-induced threats in preserves in the Northeast Los Osos, South Los Osos and West Pecho Conservation Planning Areas with no greater fragmentation by roads, residences, or other areas of human use than currently exists. (USFWS, 1998)

2. Evidence that the acreage and approximate cover classes of Morro manzanita in preserves can be maintained over time and that preserves are not made unmanageable by small size, proximity to urban development, or fragmentation. (USFWS, 1998)

3. Site-specific management plans have been successfully implemented for the preserves. Because habitat in the Conservation Planning Areas must remain unfragmented to recover this species, habitat attrition must be restricted to isolated or remnant patches of Morro manzanita that are unlikely to be viable over the long term. Highest priority for securing sites should be given to stands where Morro manzanita is the dominant in terms of cover, where large blocks of occupied habitat are still present, and where Morro manzanita habitat can be secured that abuts other protected lands, as in the South Los Osos Conservation Planning Area. (USFWS, 1998)

**Recovery Actions:**
- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS,

1998)

- Recommendation from 2013 5-Year Review: 1. Additional lands with high densities of Arctostaphylos morroensis should be secured from the threat of development in Northeast Los Osos, West Pecho, and South Los Osos conservation planning areas. (USFWS, 2013)
- Recommendation from 2013 5-Year Review: 2. All secured lands should be managed to ensure ecosystem function. Active management is needed to maintain and enhance populations of Arctostaphylos morroensis; therefore, the development and implementation of management plans that identify specific actions for the species are critical to its recovery. At a minimum, these plans need to address: (a) regeneration requirements for the species; and (b) an assessment of the extent of the threat of competition from nonnative invasive plant species. The Service should work with CDPR, CDFW, and other relevant partners to encourage the development and implementation of these management plans. (USFWS, 2013)
- Recommendation from 2013 5-Year Review: 3. Ensure that management actions are implemented and ongoing by securing and using funding sources. Engage partners (State Parks and/or the County of San Luis Obispo) in an effort to work with them toward the common goal of securing the long-term persistence of Arctostaphylos morroensis.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Coordinated conservation and research are needed to better understand the biology and ecology of Morro manzanita, in particular to restore and maintain the existing stands and facilitate recruitment. These efforts should include: • Conduct a more-detailed analysis of the distribution and abundance of and threats to Morro manzanita, with a coordinated team effort including site visits by USFWS and partners. • Conserve and protect habitat in vicinity of and near existing stands of Morro manzanita • Develop and implement site-specific management plans for Morro manzanita habitat within preserves including success criteria for evaluating effectiveness of management. • Conduct modelling to anticipate the effects of climate change on distribution and abundance of Morro manzanita, including changes in temperature, precipitation, extent of marine fog layer, and sea level rise. • Develop protocols for long-term restoration success. 1. Consider using method with seedlings of Sarafian (2011, p. 5), and suggested method for collecting and sowing seeds of Tyler and Odion (2020, p. 164). 2. In light of the threat of climate change with severe drought and increased temperatures, consider using methods for cultivating seeds for propagation and outplanting in arid lands used by Abella et al. (2012, entire), Abella et al. (2015, entire), Abella (2017, entire) and Abella et al. (2020, entire). • Continue studies of the species' relationship with fire. • Collect seeds for conservation seed banking. • Introduce Morro manzanita into living collections at several botanic gardens (USFWS, 2022).

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# SPECIES ACCOUNT: *Arctostaphylos myrtifolia* (Ione manzanita)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened: listed in 1999 (64 FR 28403)

**Physical Description**

Ione manzanita is an evergreen shrub of the heath family (Ericaceae). Reaching a height of generally less than about 4 feet (1.2 meters) and commonly only 2 feet (0.6 meter) tall, plants appear low and spreading. Its bark is red, smooth, and waxy. Olive-green leaves are small 1/4 to 1/2 inch (0.6 to 1.3 centimeters), oval in shape, pointed at the tip, and often pointed at the base as well. The white to pinkish urn-shaped flowers are also small, averaging 1/8 inch (0.3 centimeters) across, and appear from January to February. Its small, rounded, greenish fruits are 1/8 inch (0.3 centimeters) long and 1/16 inch (0.15 centimeter) wide. This manzanita species lacks a basal burl (a basal burl is a swelling at the junction of roots and stems that allows many chaparral shrub species to sprout from the base, and vegetatively regenerate after a fire). After a fire, Ione manzanita must regenerate from seed. Ione manzanita can be distinguished from other species in the same genus by its smaller stature and the color of its leaves (NatureServe 2014; USFWS 2009; USFWS 2010).

**Historical Range**

Ione manzanita occurs throughout all of its presumed historical range in Amador County, though many populations have been reduced in size due to mining, road construction, development, and diseases. The distribution of Ione manzanita was believed to extend as far east as the Town of San Andreas in Calaveras County. However, efforts to locate and identify the San Andreas populations of Ione manzanita have not been successful. Because of the discontinuous nature of the Ione Formation on which it grows, Ione manzanita was always patchily distributed with other chaparral and oak forest types (USFWS 2010; NatureServe 2014).

**Current Range**

Ione manzanita occurs in about 100 individual stands, which cover a total of about 1,000 acres (4 square kilometers). It is narrowly endemic to a habitat found only in the central Sierra Nevada foothills of California. At the time of listing, Ione manzanita was known from 17 occurrences covering approximately 1,000 acres (4 square kilometers); currently, the Calflora Occurrence Database (Calflora 2014) contains 94 records for Ione manzanita from Amador and Calaveras Counties, and the CNDDB (2014) recognizes 15 occurrences for this species. Most of the occurrences are on private lands. One occurrence on U.S. Bureau of Land Management (BLM) land is within the Ione Manzanita Area of Critical Environmental Concern. Two additional occurrences are partially on BLM lands. Four small, pure (containing only Ione manzanita) populations and several smaller, mixed populations also occur on the State-owned Apricum Hill Ecological Reserve managed, by the California Department of Fish and Wildlife (USFWS 2010; CNDDB 2014; NatureServe 2014).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food Source**
Adult: sunlight

**Food/Nutrient Narrative**
Adult: This species is a plant that aquires its energy from sunlight via photosynthesis.

**Reproductive Strategy**
Adult: Flowering plant

**Lifespan**
Adult: unknown

**Dependency on Other Individuals or Species**
Adult: unknown

**Breeding Season**
Adult: January and February (Calflora 2014; CNPS 2014).

**Key Resources Needed for Breeding**
Adult: unknown

**Reproduction Narrative**
Adult: Flowering occurs from mid-January to early March and fruits are fully developed by late spring or early summer (Gankin and Major 1964, p. 796). Arctostaphylos myrtifolia is an obligate seeder that can be killed by fire and therefore depends entirely on seeds stored in the soil or dispersed to the site for stand regeneration (Gankin and Major 1964, p. 795).

**Habitat Type**
Adult: barrens, shrubland/chaparral

**Dependencies on Specific Environmental Elements**
Adult: 190 to 1,900 feet (60 to 580 meters) (CNPS 2014) with soils that are highly acidic, and high levels of aluminum

**Geographic or Habitat Restraints or Barriers**
Adult: restricted to Ione Formation

**Spatial Arrangements of the Population**
Adult: clumped according to suitable resources

**Environmental Specificity**
Adult: special habitat requirements, but not special feeding requirements

**Tolerance Ranges/Thresholds**
Adult: low

**Site Fidelity**

Adult: high; plants do not move once they become established

**Habitat Narrative**

Adult: Ione manzanita occurs on outcrops of the Ione Formation (a remnant Eocence, hard white sandstone formation) in an area of about 22,500 acres (91 square kilometers) in Amador County. A few separate populations occur in Calaveras County. The populations range in elevation from 190 to 1,900 feet (60 to 580 meters) (CNPS 2014), with the largest populations occurring at elevations between 295 and 900 feet (90 and 275 meters) (USFWS 2009; USFWS 2010). Ione manzanita is mostly confined to the unusual soils of the Ione formation. These soils are highly acidic, and contain high levels of aluminum. This soil environment is extremely hostile to the growth of most plants (aluminum in high concentrations can be toxic to plants). Organic matter and nutrient availability is low. Ione manzanita only occupies sites where the extreme conditions described above persist. It commonly grows in pure stands; at the edge of these stands, there may be a transition zone where Ione manzanita and whiteleaf manzanita coexist. It also occurs in transitional zones with surrounding taller chaparral types, but it does not persist if it is shaded (USFWS 2009; USFWS 2010; NatureServe 2014).Some manzanita species have basal burls that can resprout after a fire burns the canopy; Ione manzanita does not have a burl. It is an obligate seeder that can be killed by fire. It depends entirely on seeds stored in the soil or dispersed to the site; seed germination may be promoted by periodic fire (USFWS 2010).

***Dispersal/Migration***

**Motility/Mobility**

Adult: not moble

**Dispersal**

Adult: unknown

**Dependency on Other Individuals or Species for Dispersal**

Adult: unknown

**Dispersal/Migration Narrative**

Adult: There is not much information available regarding the dispersal of this species

***Population Information and Trends***

**Population Trends:**

Unknown

**Species Trends:**

Declining

**Population Growth Rate:**

unknown

**Number of Populations:**

17

**Population Size:**
unknown, but likely greater than 100 individuals

**Minimum Viable Population Size:**
unknown

**Resistance to Disease:**
low

**Adaptability:**
low

**Population Narrative:**
Current status and number of individuals is unknown. At the time of listing Arctostaphylos myrtifolia was known from 17 occurrences covering approximately 404.7 ha (1,000 ac)Individuals occur in stands, with approximately 100 stands documented as still existing. Populations exist in a narrow geographic range that contains the required soil conditions; they occur primarily on private or non-Federal lands. The amount of Ione manzanita habitat lost to mining and has not been quantified, because information regarding the total acreage of land newly disturbed by mining operations is proprietary. However, the loss is believed to be significant. Populations are restricted to a very limited habitat, with much of that population suffering from disease. The ability of populations to recover is limited by poor health and reduction of habitat. There are only about 100 stands, with an unknown number of individuals in a limited area of habitat. A significant portion of those populations are suffering from disease. Populations are restricted to habitat in the Ione Formation soil conditions. Loss of habitat due to mining and other development removes potential area for regrowth.

***Threats and Stressors***

**Stressor:** Mining
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nearly all populations of this species occur on private or non-Federal land. The primary threat facing this species is the ongoing and threatened destruction and modification of its habitat by mining for silica sand, clay, lignite, common sand and gravel; and reclamation of mined lands involving establishment of vegetation with which this species cannot co-exist. A lesser degree of threat is posed by commercial or residential development, clearing for agriculture and fire protection, and continued erosion due to previous fireline construction and driver training for California Department of Forestry and Fire Protection (CDFFP) employees. Commercial and residential development also threatens the habitat of Arctostaphylos myrtifolia. In 1993, a 43 ha (106 ac) parcel in the city of Ione reported to have A. myrtifolia was cleared, presumably to facilitate future development (Randy L. Johnsen, Ione City Administrator, in litt. 1994). The Amador County master plan has zoned an area in the northern Ione chaparral near Carbondale for industrial uses. Its habitat occurs in areas that contain valuable minerals. Clay mining began in the Ione area around 1860. Since that time, the Ione area has produced about a third of the fire clay in California (Chapman and Bishop 1975). Lignite, a low-grade coal, also has

been mined in the Ione area since the early 1860s, initially for fuel, but more recently for wax used for industrial purposes. Chapman and Bishop (1975) reported the Ione lignites were the only lignites used commercially in the United States in the production of a specialized wax (montan wax). Quartz sand used in making glass containers, and laterite used for making cement also are commercially mined in the Ione area (Chapman and Bishop 1975). Common sands and gravels are also mined for various uses. Mining of all of these deposits has resulted in the direct removal of habitat for this plant species (Wood and Parker 1988; V. Thomas Parker, Professor of Biology, San Francisco State University, in litt. 1994; M. Wood, in litt. 1994). Strip mining of silica for glass and clay for ceramics and industrial filters has extirpated (caused extinction of) populations of A. myrtifolia north and south of Highway 88 (Roof 1982). mining results in conversion of former habitat to rangeland, pasture, and other agricultural uses; landowners do not restore the original plant community that was lost when the area was mined. Additionally, once the area is mined, the specialized substrate required by the plants may no longer be present. This type of disturbance permanently precludes restoration of habitat suitable for Arctostaphylos myrtifolia. To a lesser extent, land conversion to grazing and agriculture also has degraded or destroyed the habitat for these plants (Wood and Parker 1988; V.T. Parker, in litt. 1994; M. Wood, in litt. 1994). Both activities continue to pose threats to its habitat.

**Stressor:** Disease
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recent studies by Swiecki and Bernhardt (2003, pp. 1–49) and Swiecki et al. (2005, pp. 1–38) determined that at least three different diseases are affecting the health of Arctostaphylos myrtifolia in the Ione area. First, a branch canker disease caused by a species of Fusicoccum that had previously been identified, and two newly identified pathogens, Phytophthora cinnamomi and P. cambivora. Progressive dieback associated with Fusicoccum spp. cankers likely contributes to and may sometimes cause the death of A. myrtifolia plants. Phytophthora spp. were found to cause contiguous patches of mortality in stands of A. myrtifolia due to root and crown rot (Swiecki and Bernhardt 2003, p. 4; Swiecki et al. 2005, p. 22). While mortality associated with Phytophthora spp. appears to have been noted since the 1980’s, Swiecki and Bernhardt (2003, p. 41) believe it was at least partially confused with the branch canker disease because both diseases can occur together in the same area. However, mortality associated with Fusicoccum spp. tends to be patchily distributed within a stand and mortality caused by Phytophthora spp. is continuous. Swiecki and Bernhardt (2003, pp. 41–43) determined that two species of Fusicoccum affect Arctostaphylos myrtifolia plants by killing off branch tips or infecting larger diameter stems where the infection may expand and girdle the stem. The girdling of the stem may result in the death of large portions of the plant or the plant in its entirety. Swiecki and Bernhardt (2003, p. 41) observed that stem cankers associated with Fusicoccum spp. may expand slowly during the months from March to October; however, if the die-back associated with Fusicoccum spp. exceeds new growth, individual plants may eventually be killed. Although advancement of the disease appears to be reduced during the drier months, stem canker severity, and subsequent dieback, appears to be related to plant water stress (Swiecki and Bernhardt 2003, p. 43). Arctostaphylos myrtifolia is highly susceptible to the pathogen Phytophthora cinnamomi. The P. cinnamomi pathogen was first identified as affecting A. myrtifolia by Swiecki and Bernhardt (2003, p. 5). Phytophthora cinnamomi is considered to be a serious pathogen of agricultural crops and native plant communities. In California, it is known to infect avocado trees, orchard trees, ornamental plants and Christmas tree farms (Swiecki and Bernhardt 2003, p. 44). More

recently P. cinnamomi was identified to be partially responsible for mortality in Quercus agrifolia (coast live oak) (Garbelotto et al. 2006, p. 1). Phytophthora cinnamomi is a disease that causes root and crown rot and is responsible for killing off large patches of A. myrtifolia in the Ione area. Once infected by this pathogen, the root system of the plant begins to decay until the loss of roots and/or water-conducting tissues causes the plant to desiccate (Swiecki and Bernhardt 2003, p. 43). Additionally, P. cinnamomi can also infect the leaves and stems of the plant, providing the same symptoms as Fusicoccum infections, making it difficult to determine which disease is affecting a particular plant (Swiecki and Bernhardt 2003, p. 45). Introduction of Phytophthora cinnamomi into Arctostaphylos myrtifolia habitat represents longterm, if not permanent, destruction of habitat due to its long persistence in the soil (Swiecki and Bernhardt 2003, p. 43). Phytophthora cinnamomi can persist in the environment in the absence of susceptible hosts. This pathogen survives in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003, p. 44). There is no known cure or prevention for this A. myrtifolia disease (Swiecki and Bernhardt 2003, pp. 45–47). Swiecki and Bernhardt (2003, pp. 26–27) found that A. myrtifolia regeneration within an older portion of a mortality center was killed off by P. cinnamomi, while Swiecki et al. (2005, p. 25) discovered healthy A. myrtifolia regeneration in other older portions of mortality centers. However, subsequent investigation in 2009 discovered regeneration in these mortality centers displayed extreme dieback, or complete mortality (Karuzas, in litt. 2009, p. 1). Swiecki et al. (2005, p. 330 further noted that although reductions in pathogen populations may occur over time, it is unclear what period of time is needed to allow successful reestablishment of A. myrtifolia. The pathogenic activity of Phytophthora cinnamomi is favored by free moisture and under wet conditions, multiple infection cycles are likely to occur. Phytophthora cinnamomi is primarily spread to new areas through the movement of infested soil by humans, particularly through the use of vehicles (Swiecki and Bernhardt 2003, p. 45). Once the disease has been introduced into an area, the movement of the pathogen is facilitated by water flow. Swiecki et al. (2005, p. 33) noted that the local spread of P. cinnamomi occurs during the wet season at a cross slope and upslope rate of approximately 0.25 m (0.8 ft) per year. Down slope spread has been calculated at 2 m (6.5 ft) per year, presumably due to transport via flowing water, and under stagnant stream conditions P. cinnamomi has been located 10 m (33 ft) from disease-associated mortality centers (Swiecki et al. 2005, p. 34). While it is more likely for P. cinnamomi infected soil to be spread over larger distances during the wet season, movement of infected soils can readily occur during dry months as the result of mining operations and excavation (Swiecki et al. 2005, p. 35). An investigation of the distribution of the Phytophthora cinnamomi pathogen throughout the range of Arctostaphylos myrtifolia found that P. cinnamomi infection is widespread throughout the Ione and Buena Vista area, with a second disease center in the Carbondale area (Swiecki et al. 2005, pp. 1–38). Of the populations located in and around Ione and Buena Vista, over 50 percent have been killed by disease or are at risk of being infected (Swiecki, in litt. 2008, p. 1). DNA microsatellite analysis of P. cinnamomi isolates from Apricum Hill Preserve identified four genetically distinct variants, suggesting multiple introductions of the pathogen at this location. Additionally, two of the four genotypes have been identified elsewhere in California (Swiecki et al. 2005, pp. 28–29). Investigation of the A. myrtifolia mortality on BLM land in the Carbondale area resulted in the discovery of a second soil-borne Phytophthora species, P. cambivora (Swiecki et al. 2005, p. 36). While it is not known what effect P. cambivora has on A. myrtifolia, P. cambivora is closely related to P. cinnamomi and is also an aggressive root pathogen (Swiecki et al. 2005, p. 36). Phytophthora cinnamomi is currently considered to be the greatest threat to Arctostaphylos myrtifolia. As of 2005, P.cinnamomi was documented as occurring in two of the five large A. myrtifolia populations. However, because P. cinnamomi is causing mortality in a number of native forests and chaparral communities in northern California (Swiecki, in litt. 2008, p. 2), and contaminated soil is readily transported on vehicles and in nursery stock, it is likely that P. cinnamomi will spread throughout the range of A. myrtifolia in the foreseeable future.

**Stressor:** Inadequate regulations
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Regulatory mechanisms thought to be inadequate to protect Arctostaphylos myrtifolia included: (1) the CEQA; (2) the SMARA; and (3) local regulations (see five year review for more information).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 5C

**Delisting Criteria:**
Not available

**Recovery Actions:**

- Currently there is no approved final or draft recovery plan for Eriogonum apricum (inclusive of vars. apricum and prostratum) or Arctostaphylos myrtifolia, therefore a high priority action should be finalizing a recovery plan for these species. Disease is currently the greatest threat to A. myrtifolia, and as such, a high priority should be placed on identification of the current extent of this pathogen within the range of A. myrtifolia and implementing measures to restrict the movement of infested soil and plant materials from areas affected by Phytophthora cinnamomi. Additional emphasis should be placed on conducting research into how to eliminate this disease from the ecosystem and identify other methods to prevent disease transmission. As part of this effort, the symptomatology, etiology, and impact of P. cambivora on A. myrtifolia and other species should be studied. Additionally, priority should be placed on identifying the status of E. apricum populations and obtaining an accurate representation of the area occupied by this species and the availability of habitat for restoration purposes. These tasks would aid us in better understanding the threats facing these species and to develop methods to help reduce the threats.

**References**

FEMA species account

five year review

Nature Serve

five year review 2010

final listing rule

# SPECIES ACCOUNT: *Arctostaphylos pallida* (Pallid manzanita)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened

**Physical Description**

Pallid manzanita is an upright, evergreen shrub, usually 1.5 to 13 feet (2 to 4 meters) tall, but occasionally much taller. The bark on the main branches is gray to reddish. The leaf blades are 0.75 to 1 inch (2.5 to 4.5 centimeters), and a pale, dull-green color. Flowers are white and urn-shaped, 0.23 to 0.27 inch (6 to 7 millimeters) long, in dense clusters (USFWS 2014; Jepson 2013). Additional detail from 2015b: Arctostaphylos pallida is an upright, evergreen, non-burl-forming, obligate-seeding shrub. It grows up to 4 meters (13 feet) in height, with rough, gray, or reddish bark. The twigs (terminal branches) are bristly and canescent (covered with whitish fine hairs). The pale green leaves surround the stem and are attached by a petiole less than 2 millimeters (0.08 inch). The leaves are closely imbricated (overlap), and are cordate (heart-shaped) and glabrous (hairless). The leaf blade is 2.5 to 4.5 centimeters (1.0 to 1.8 inches) long, 2 to 3 centimeters (0.8 to 1.2 inches) wide, ovate or oblong-ovate, glaucous (covered with a whitish waxy covering), dull, and smooth (Wells 1993). The inflorescences (cluster of flowers) are dense, 3 to 5 per branch; the bracts (leaflike organ subtending an inflorescence) are 5 to 9 millimeters (0.2 to 0.35 inch), widely lanceolate (narrow and tapering at both ends), and acute (sharply pointed) (Wells 1993). The flowers are white, rose, or white-rose in color, urn-shaped, and 6 to 7 millimeters (0.2 to 0.3 inch) long; and flowering occurs from December to March. Fruits are 8 to 10 millimeters (0.3 to 0.4 inch), globe-shaped, and sticky (Wells 1993). (USFWS, 2015b).

**Taxonomy**

Arctostaphylos pallida was first described by Eastwood (1933), based on a specimen collected by W. W. Carruth in 1902 from the “East Oakland Hills.” Prior to Eastwood (1933), the specimen was included in Arctostaphylos andersonii. Jepson (1922; 1939) did not recognize A. pallida as a separate species and continued to include it in Arctostaphylos andersonii. McMinn (1939) published the combination A. andersonii var. pallida, apparently agreeing with J. E. Adams’ conclusions (first presented in his 1935 dissertation at the University of California at Berkeley) that the Oakland specimen was distinct but related to A. andersonii. This combination was not published until several years later (Adams 1940). In their floristic treatment of California, Munz and Keck (1959) followed McMinn’s treatment. Wells (1969) recognized A. pallida as a species separate from A. andersonii and retained this treatment in the Jepson Manual (Wells 1993). The phylogenetic analysis and relationships outlined in Boykin et al. (2005) do not support A. pallida as being a variety of A. andersonii. Although Parker et al. (2012) revised the taxonomy of several Arctostaphylos species for the second edition of the Jepson Manual; no taxonomic revisions were made to A. pallida. Arctostaphylos pallida is recognized as a full species (Parker et al. 2012).

**Historical Range**

Pallid manzanita has a historical range in the Contra Costa Hills in the northern Diablo Range in Alameda and Contra Costa counties, California (NatureServe 2014). It was collected on the summit of East Oakland Hills in January of 1902. A second population, which was believed to have been reported in the 1940s or 1950s, was on Sobrante Ridge in Contra Costa County (USFWS 2014). Added in 2015: Based on a personal communication with the late James Roof, the founding director of East Bay Regional Parks District's (EBRPD) Tilden Regional Park Botanical Garden (Tilden Park; Amme et al. (1987) noted that Mr. Roof planted several dozen A. pallida, in the period between 1939-1940, along Shasta Road and Golf Course Drive in Tilden Park. (USFWS, 2015b).

**Current Range**

There are 13 documented occurrences where pallid Manzanita currently exists. All extant, naturally occurring populations are in two geographic regions: Huckleberry Ridge in Alameda County, and Sobrante Ridge in Contra Costa County. There are likely dormant seed banks of pallid manzanita in the range of the species, as indicated by the presence of germinated seeds at several sites in Joaquin Miller Park following soil disturbance and/or burning (USFWS 2014). The largest concentration of pallid manzanita occurs on Huckleberry Ridge, with many stands distributed across connected and adjacent ridge tops. The largest stands by number and size occur along the boundary between East Bay Regional Park District's (EBRPD) Huckleberry Botanic Regional Preserve, and private properties to the west, primarily on northeast-facing slopes and extending southwest over the top of the ridge into the urban development of Skyline Boulevard. The second-largest concentration of pallid manzanita occurs at Sobrante Ridge in EBRPD's Sobrante Ridge Ecological Preserve. A 2004 survey indicated the population existed within 1.33 acres at Sobrante Ridge. There also exists a small, naturalized population at Tilden Park that is divided into two stands. One is scattered along the roadside of Wildcat Canyon Road, and the other is along the Selby Trail north of Shasta Road (CNPS 2014, USFWS 2014).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food Source**

Adult: sunlight

**Competition**

Adult: yes (see threats section)

**Food/Nutrient Narrative**

Adult: This species acquires its energy from sunlight via photosynthesis.

**Reproductive Strategy**

Adult: diploid, obligate seeding; also capable of reproducing vegetatively by layering

**Dependency on Other Individuals or Species**

Adult: Depends on bees for pollination; seed caching by seed predators may be important for surviving fires

**Key Resources Needed for Breeding**

Adult: fire

**Reproduction Narrative**

Adult: Arctostaphylos pallida is diploid, obligate seeding, and shade-intolerant (Amme and Havlik 1987). Bees and other insects in the superfamily Apoidea, in particular European honeybees (Apis melifera), appear to be important pollinators (Amme and Havlik 1987, B. Solvesky, Service, pers. obs. 2010). Two basic life history patterns are found among species within the genus Arctostaphylos with respect to wildfire; Arctostaphylos plants either survive wildfire and resprout from a basal burl (sprouter) or Arctostaphylos plants are killed by fire and regenerate from seeds stored in the soil (obligate seeder). Obligate seeding Arctostaphylos species, like A. pallida, may require 5 to 25 years before substantial seed crops are produced (Keeley 1986). Seeds typically suffer high rates of predation (Kelly and Parker 1990); however, seed caching by seed predators may be an important mechanism by which seeds are buried to a sufficient depth at which they may survive high-intensity wildfires. Parker (2010) found that while overall seedling density declined with fire intensity, the proportion of seedlings emerging from rodent caches increased. Seeds that are not depredated on are slowly added to the soil seed bank, eventually reaching depths at which they can survive fire (Parker 2007). Obligate seeding Arctostaphylos species tend to have fire-dependent seedling recruitment; and mature stands tend to be even-aged, exhibiting little to no regeneration during fire-free intervals (Safford and Harrison 2004). Mechanical disturbance may be an alternative to fire under certain conditions. The regeneration of seedlings at stands where vegetation management activities disturbed the soil and increased light levels, in the absence of fire, indicates fire is not required for seed germination to occur. However, based on the large number of seedlings that occur at Huckleberry Preserve as the result of a pile burn, compared to other stands with seedlings where fire has not occurred, fire is likely a more effective means of stimulating germination. In addition to being an obligate seeder, A. pallida can reproduce vegetatively by layering. Layering occurs when branches become partially or fully buried in soil or litter and produce roots. Some extensive clones of A. pallida have developed in this manner within the Sobrante Ridge population (Amme and Havlik 1987).The understory of mature Arctostaphylos pallida stands and chaparral vegetation in general is typically free of vegetation, including regeneration. The cause of the lack of vegetation beneath chaparral species has been attributed to allelopathy (inhibitory biochemical interactions between plants), small mammal herbivory, and/or fire dependant seed banks. Keeley and Keeley (1989) concluded that in nature, a substantial proportion of the seed pool of some chaparral species is unlikely to germinate in the absence of fire and that dormancy mechanisms minimize seed germination during periods of low-survival probability. However, they also note that a portion of the seed pool is potentially capable of germinating in the absence of fire. A study comparing the regeneration and recolonization of obligate-seeding to sprouting Arctostaphylos after fire found that the seedlings of obligate seeders did not compete well against sprouters post-fire; thus, seedlings are adapted to openings in chaparral after fire (Keeley and Zelder 1978). Based on this observation, Keeley and Zelder (1978) hypothesized that longer fire-free periods favor obligate seeders by creating more and larger openings in chaparral post-fire, because: (1) longer fire-free periods result in higher fuel loads and more intense fires, thereby reducing the number of sprouters that survive fire; and (2) long fire-free periods allow for increased stem-exclusion, thereby reducing the density of potential sprouters after a fire. In support of this hypothesis, Odion and Davis (2000) found that chaparral with dense canopy cover prior to fire tended to be barren after fire, where heating was relatively high, except for the occasional obligate seeding Arctostaphylos and obligate seeding Ceanothus. The authors also noted that obligate seeders tended to have deeply buried seeds, allowing them to withstand prolonged soil heating. A study of the effects of prescribed fire on A. morroensis (Morro manzanita), a closely related species to A. pallida (Boykin et al. 2005) and a federally endangered obligate-seeding species from Morro Bay, California, found that A. morroensis may require considerably longer than 40 years between fires to establish a deeply buried seed bank with enough viable seed to adequately compensate for mortality and prevent population decrease or local extinction (Odion and Tyler 2002). However, it is not clear how long it takes to produce a persistent soil seed bank in which seeds are buried deep enough to withstand fire (Parker 2007).

**Habitat Type**

Adult: maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees

**Dependencies on Specific Environmental Elements**

Adult: cool air temperatures that experience maritime fog

**Geographic or Habitat Restraints or Barriers**

Adult: likely restricted to the northwestern extremity of the Diablo Range (see Misc. Section)

**Spatial Arrangements of the Population**

Adult: clumped according to suitable resources

**Environmental Specificity**

Adult: Narrow; special habitat requirements

**Tolerance Ranges/Thresholds**

Adult: shade intolerant

**Site Fidelity**

Adult: very high

**Habitat Narrative**

Adult: The primary soil series Arctostaphylos pallida occurs on, including the large stands and satellite stands along Huckleberry Ridge and portions of Sobrante Ridge and Tilden Park, is Millsholm loam (NRCS 2013). The Millsholm soil series consists of shallow, well-drained soils that formed in material weathered from sandstone, mudstone, and shale. In addition to Millsholm loam, A. pallida occurs on other shallow well-drained soils series, rock formations, and soil complexes with parent materials that include shale, schist, greenstone, sandstone, silty clay loam, or conglomerate. The Huckleberry Preserve and the Sobrante Ridge stands grow on soil composed of Middle Miocene cherts and shales of the Monterey Group (Amme and Havlik 1987). These soils are thin, well drained at the surface, and deficient in many essential plant nutrients. However, the fractured and bedded rocks below hold water that is accessible to deep roots. Satellite stands along Skyline Boulevard occur on Pinehurst Shale and the Joaquin Miller Formation; both substrates are mixtures of shale, sandstone, and minor conglomerate. The stand along Exeter Drive occurs on soft sandstone. Arctostaphylos pallida appears to only grow on these soils in areas that experience maritime summer fog, and have not been found on the same substrates where summer air and soil temperatures are higher (Johnson 1983). Arctostaphylos pallida is a component of the maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees, including A. crustacea subsp. crustacea (brittle leaf manzanita), Vaccinium ovatum (California huckleberry), Chrysolepis chrysophylla var. minor (golden chinquapin), and several shrub-form Quercus species. Maritime chaparral represents a plant community of special concern because of the high density of narrowly distributed endemic species, its patchy distribution, and its association with forest edges or odd soils (Parker 2007). Arctostaphylos pallida is shade intolerant and will slowly die when shaded by larger trees and shrubs. However, based on the results of vegetation management activities conducted in the mid-1980s at Huckleberry Preserve, Chabot, and Big Trees Trail and in the mid-2000s at Redwood Regional Park and Big Trees Trail, A. pallida responds positively to activities that reduce light competition and disturb the soil. Four vegetation types exist on Sobrante Ridge: maritime chaparral, oak woodland, coastal scrub, and grassland (Amme and Havlik 1987). The area outside of the shale soil formation is dominated by open park-like coast live oak woodland, interspersed with grassland and coastal scrub; while the area within the shale soil formation is dominated by maritime chaparral, including A. pallida and A. crustacea subsp. crustacea. Within the approximately 3.6-hectare (9-acre) shale soil formation, primarily along the edges, are A. custacea subsp. crustacea; within the center of the formation is the largest concentration of A. pallida, occurring on both east- and southwest-facing slopes. There are two vegetation types within the Huckleberry Preserve stand: maritime chaparral and oak/California bay laurel (Quercus species/Umbellularia californica) woodland. As is the case at Sobrante Ridge, the most barren soils at Huckleberry Preserve are occupied by the largest concentrations of Arctostaphylos pallida. Unlike the large stand at Huckleberry Preserve and the Sobrante Ridge, the soils of the satellite stands of the Huckleberry Ridge population are more developed and less nutrient deficient, capable of supporting redwood and coast live oak vegetation types. As such, the A. pallida at these sites occur mainly on roadcuts and within forest gaps.

***Dispersal/Migration***

**Motility/Mobility**

Adult: not mobile

**Dispersal**

Adult: only the seeds can disperse

**Dispersal/Migration Narrative**

Adult: There is not a lot of available dispersal information on this species.

***Population Information and Trends***

**Population Trends:**

some declining and some with unknown status

**Species Trends:**

unknown

**Population Growth Rate:**

unknown

**Number of Populations:**

3 (2 Naturally occurring. 1 Naturalized) (USFWS, 2023)

**Population Size:**

The most recent counts have estimated the population to be 2,444 mature plants and 133 seedlings (USFWS, 2023).

**Minimum Viable Population Size:**

unknown

**Resistance to Disease:**

low

**Adaptability:**

low

**Population Narrative:**

Distribution: At the time of listing, the pallid manzanita was known to be distributed between two naturally occurring populations and a single naturalized population. The distribution of the three populations have not significantly changed. The Huckleberry Ridge population is the largest known population and exists as a large colony with several satellite colonies. The population at Huckleberry Ridge occurs within East Bay Regional Park District's (EBRPD) Huckleberry Botanic Regional Preserve (Huckleberry Preserve), East Bay Municipal Utility District (EBMUD) managed areas, City of Oakland owned land, Pacific Gas and Electric power line easements, and on private property. Since listing, two colonies have been extirpated (Table 1). The second population occurs at Sobrante Ridge, within EBRPD's Sobrante Ridge Ecological Preserve. The third population was planted in the 1930s–1940s and occurs near the Tilden Park Botanical Garden (Tilden Park) in Contra Costa County (USFWS, 2023). Abundance: At the time of listing, the total population size was determined to be around 4,385 plants (Service 2011, p. 3). During the 2011 status review, the total population size was determined to be around 1,350 mature plants and 295 seedlings (Service 2011, p. 3). The most recent counts have estimated the population to be 2,444 mature plants and 133 seedlings. Table 1 below details most recent survey years for the different colonies within the three populations, and their most recent counts. Some of the increases may be explained by habitat management; at Chabot in Joaquin Miller Park, 125 seedlings germinated following extensive tree removal – with scarification from raking suspected to have assisted seed germination (Ella Matsuda, Friends of Sausal Creek, pers. comm. 2023). Similarly, on EBMUD managed lands, the number of pallid manzanitas more than tripled after the removal of over-shading trees (East Bay Municipal Utility District 2020, p. 12). Other increases can be linked to the discovery of new individuals and potential differences in counting of individuals from previous survey years; at the Huckleberry Preserve, surveys were completed in previously unmonitored areas where new mature plants were discovered (Californian Environmental Services 2018, p. 196). Lastly, a small colony of 10 outplanted individuals was propagated from cuttings taken by Friends of Sausal Creek between 2018 – 2023 (Ella Matsuda, Friends of Sausal Creek, pers. comm. 2023); limited information is available on the outplanted colony (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Disease
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Recently, Phytophthora cinnamomi has been confirmed infecting and killing A. pallida plants at Huckleberry Preserve and the Big Trees Trail stands. In contrast to the unidentified fungal pathogen, A. pallida infected with P cinnamomi die within several months of signs of infection and do not experience branch or stem dieback while maintaining healthy branches and meristems. To our knowledge, the extent of the infestation within stands of A. pallida has not been quantified and the potential for widespread population decline is still unknown. The pathogenic activity of Phytophthora cinnamomi is favored by free moisture, and under wet conditions multiple infection cycles are likely to occur. Phytophthora cinnamomi is primarily spread to new areas through the movement of infested soil by humans, particularly on vehicle tires, but also on shoes, tools and equipment that become contaminated with infested soil (Swiecki and Bernhardt 2003). In addition, P. cinnamomi has been isolated from container stock purchased from several native plant nurseries, suggesting nursery stock used for restoration projects or planted within the Wildland Urban-Interface (WUI) can provide a vector for this disease (Swiecki et al. 2011). In addition, a high percentage of woody plant materials from commercial nurseries are infested with various root-rotting Phytophthora species, including P. cinnamomi. This not only increases the likelihood that remnant plants in landscapes will be killed by this pathogen, but further increases the risk to stands in the vicinity of landscaped parcels, especially where landscaped parcels are located upslope of A. pallida stands (e.g., Manzanita Drive area) (T. Swiecki pers. comm. 2012).Human transport of contaminated soil is the primary vector for introducing Phytophthora cinnamomi into new areas. Most Arctostaphylos pallida stands occur along ridge tops, adjacent to unpaved maintenance roads and trails, increasing the likelihood contaminated soils will be spread throughout the East Bay Hills on shoes, bicycles, and vehicles. Once Phytophthora cinnamomi has been introduced into an area, its movement is facilitated by water flow, especially downhill. Swiecki et al. (2005) noted that the local spread of P. cinnamomi in A. myrtifolia occurs during the wet season at a cross-slope and upslope rate of approximately 0.25 meter (0.8 foot) per year. Down slope spread has been calculated at 2 meters (6.5 feet) per year, presumably due to transport via flowing water (Swiecki et al. 2005). Over a longer time interval, Swiecki and Bernhardt (2012) have documented that P. cinnamomi has spread at average rates about 1 meter (3.3 feet) per year in relatively level sites within A. myrtifolia stands.Introduction of Phytophthora cinnamomi into Arctostaphylos pallida habitat represents a long-term and substantial threat. Phytophthora cinnamomi can persist in the environment in the absence of susceptible hosts, surviving in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003). There is no known cure for plants that have been infected. Prevention of this disease depends on the exclusion of the pathogen from areas that contain host plants.

**Stressor:** Fire frequency
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A lack of frequent small fires to stimulate regeneration and reduce fuel loads within stands of chaparral represented one of the greatest threats to the species. There has been considerable debate about the effects of decades of fire suppression on chaparral ecosystems (Moritz 2003). One side of the debate argues that fire suppression has increased fuel loads which lead to fewer, but larger wildlfires. This theory is supported by studies contrasting shrubland fire regimes north and south of the U.S.-Mexican border (Minnich 1983, 1995, 2001), suggesting that

the pattern of frequent small fires south of the boarder is a model of what fire regimes were like north of the boarder prior to fire suppression policy. Based on this assumption, proponents of this theory suggested that California-shrubland WUI management should de-emphasize fire suppression and reestablish an age mosaic of shrublands to return the landscape to a condition in which fire size is constrained by discontinuities in fuels due to smaller, more frequent fires.In contrast, others contend that relatively large stand-replacing crown fires are a natural part of these ecosystems and that urban expansion into these ecosystems has increased the rate of fire incidence through human ignition sources, resulting in more destructive (that is, expensive due loss the of human structures) fires. This is supported by research that has shown that frequency and area burned have not declined as a result of fire suppression (Keeley 1999), extremely large, stand replacing crown fires in California shrubland ecosystems predate fire suppression policy (Keeley and Fotheringham 2001, Keeley and Zedler 2009); over the last 130 years there has been no significant change in the incidence of large fires greater than 10,000 hectares (24,710 acres); fire suppression has not reduced the area burned (Conrad and Weise 1998, Keeley et al. 1999); large extensive fires are not dependent on stand age (Keeley et al. 1999, Moritz 2003); and when wildfires occur under severe fire conditions they burn through all but the youngest age-class of chaparral and coastal scrub (Keeley et al. 1999, Keeley 2002). Keeley and Fotheringham (2001) question the use of current fire regimes south of the border as a model of what fire regimes were like north of the border prior to fire suppression for the following reasons: (1) fire frequency from human ignition sources is five times greater south of the boarder; (2) most fires in northern Baja California, Mexico are driven by on-shore northwestern breezes, which have a different capacity for fire spread than fires driven by foëhn winds; (3) areas south of the border tend to receive less precipitation and soils tend to be less fertile, both of which affect fuel production; (4) much of the chaparral-dominated landscape south of the boarder is a plateau, lacking topographic heterogeneity, which affects the rate of fire spread and increases solar evaporation and reduced fuel production; and (5) few, if any, contiguous chaparral stands south of the boarder reach the sizes of those north of boarder. In a study of relative frequency of human-caused and lightning-caused fires in the coast range east of San Francisco Bay, Keeley (2005) found that most years were without any lightning-ignited fires: in Contra Costa County 86 percent of the years had no lightning-ignited fires and in Alameda County the figure was 74 percent. Wildfire in Alameda and Contra Costa counties is most often human caused; thus, the fire return interval is likely no longer within the evolutionary bounds of the species. Odion and Tyler’s (2002) study of Arctostaphylos morroensis indicates that a fire return interval of 40 years or less would likely result in the extirpation of the species, and other studies on obligate seeding Arctostaphylos similarly found that long fire-free intervals (with an interval greater than one fire every 100 years) likely do not represent a significant threat (Keeley and Zelder 1978, Odion and Davis 2000). Consequently, a relatively short fire-return interval, one that depletes the soil seed bank before it can be replenished, is likely a greater threat to A. pallida than a relatively long fire-return interval.Still, because fire is essential to the natural regeneration of Arctostaphylos pallida and regeneration can be difficult in the absence of fire, fire suppression remains a threat. The Huckleberry Preserve site has likely not experienced a stand-replacing fire for more than 80 years and would benefit from fire or other management activities that stimulated regeneration and reduced competition with native and non-native species. The Sobrante Ridge site likely experienced a stand-replacing fire 30 to 40 years ago (Service 1998) and appears to be healthy and vigorous. EBRPD does not typically conduct broadcast burning in the WUI due to the threat of fire escape and liability; however, EBRPD is proposing to burn slash piles at Huckleberry Preserve as part of their Wildfire Hazard Reduction and Resource Management Plan (LSA Associates, Inc. 2009) (WHRRMP). The limited opportunities to use fire to stimulate regeneration of A. pallida represents a threat to the species, because the effectiveness of mechanical soil disturbance to stimulate regeneration has not been proven to provide adequate regeneration.

**Stressor:** Goat grazing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Both EBRPD and the City of Oakland have used domestic goat (Capra aegagrus) grazing as a tool to reduce fuel loads and wildfire hazard within the WUI of the East Bay Hills. Due to the relatively indiscriminant food selection preferences of the domestic goat, this practice poses a serious, yet easily avoidable, threat to Arctostaphylos pallida. According to Kanz (2004) goat grazing by the City of Oakland is responsible for the extirpation of the Manzanita Flat stand and has caused damage to A. pallida plants at the Big Trees Trail site. The WHRRMP specifically excludes the use of goat grazing near stands of A. pallida. Goat grazing is a minor threat in areas other than City of Oakland properties, but is a significant threat to A. pallida occurring on City of Oakland properties.

**Stressor:** Succession and invasive species
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Succession of maritime chaparral to oak/California bay laurel (Quercus species/Umbellularia californica) woodland and shading by non-native invasive species such as Eucalyptus species and Pinus radiata were cited as significant threats to Arctostaphylos pallida at the time of listing and continue to represent one of the most significant threats to the species. Mosaics of grassland, oak woodland, coastal scrub, and chaparral, in some locations, have been reported to correlate with geological substrate (Cole 1980, Davis et al. 1988) and soil characteristics (Harrison et al. 1971). However, Callaway and Davis (1993) found each of these vegetation types represented abundantly on most soil depths, slope aspects, and all geological substrates. Cyclical changes between chaparral, oak woodland, grassland, and coastal scrub do occur. However, the interactions between variables responsible for vegetation type conversion and the rate of conversion are complex and site-specific. Callaway and Davis (1993) found that transition rates varied with substrate and topographic position, indicating fire, grazing, and the physical environment interacted to determine direction and rate of conversion. Variation in transition on different substrates suggests that only portions of the vegetation on the landscape may be dynamic, with some patches in certain combinations of environment and disturbance that change rapidly, and other patches that remain static as edaphic or topographic climax communities. As a broad generalization, in the absence of disturbance and on sites with environmental factors that allow for transition from one vegetation type to another, grasslands tend to transition to coastal scrub, coastal scrub to chaparral or oak woodland, chaparral to oak woodland, and oak woodland to grassland (Callaway and Davis 1993). Arctostaphylos pallida is highly shade intolerant and the invasion of tree-form plant species creates shade that causes A. pallida shrubs to slowly die over several years if management action is not taken. All of the stands of A. pallida, to some degree, show signs of succession to oak/ California bay laurel woodland and/or are being shaded by non-native trees. The Huckleberry Preserve stands and all of the satellite stands of the Huckleberry Ridge population are in severe decline due to shading via native species and non-native invasive species. For example, the Chabot stand will likely be extirpated within a decade if action is not taken that addresses this issue. Shading lowers seed

production, reduces vegetative growth, causes branch dieback and ultimately results in plant death. However, A. pallida stands that experience 100 percent mortality will likely have a viable, although declining, seed bank for many decades.

**Stressor:** Nitrogen Deposition
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Atmospheric nitrogen deposition is a complex process by which reactive chemical species of nitrogen (N), nitrogen oxides (NOX), ammonia (NH3), and their reaction products are deposited onto surfaces and enter ecosystems as N-fertilizer. As a consequence of anthropogenic inputs, the global nitrogen cycle has been significantly altered over the past century (Weiss 2006). The added N has been shown to allow nutrient-deficient soils, such as serpentine, to be invaded by both native and non-native species that require added nutrients to survive (Weiss 2006). Although it has been posited that the succession of maritime chaparral to oak/bay (Quercus species/Umbellularia californica) woodland in the East San Francisco Bay is due to fire exclusion or is a natural process, it is also possible N-deposition has created conditions that have allowed vegetation-type conversion, from maritime chaparral to oak-bay woodland, to occur on the nutrient deficient soils that are typical of Arctostaphylos pallida.

**Stressor:** Hybridization
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hybridization between Arctostaphylos pallida and other Arctostaphylos species was cited as a threat at the time of listing and continues to threaten the species today. Hybridization is known to occur naturally between A. pallida and A. crustacean. However, several species of Arctostaphylos not known to co-occur with A. pallida have been used for landscaping on private lands within the urban development adjacent to Huckleberry Preserve and threaten nearby A. pallida individuals through pollen swamping and hybridization leading to genetic assimilation. While most Arctostaphylos are diploid, about 30 percent are tetraploid. Differences in ploidy level are not a complete barrier to hybridization, and several diploid-tetraploid crosses have been observed in the field (e.g., A. crustacea X A. pallida) (Wahlert et al. 2006). From examination of populations of co-occurring diploid Arctostaphylos species in the field, in which the co-occurring Arctostaphylos species are from different genetic clades as defined in Boykin et al. (2005), there is very little or no hybridization (V.T. Parker and M.C. Vasey, unpublished data). However, A. glauca, A. pajaroensis and A. pallida are from the same genetic clade (Boykin et al. 2005) and are all diploid (Parker et al. 2012). Furthermore, hybrids have been observed between A. pallida and A. glauca (bigberry manzanita) and hybridization may be occurring in areas where residents have planted A. pajaroensis (Pajaro manzanita). This calls into question the genetic integrity of the seed bank within the City of Oakland residential development along Huckleberry Ridge and, to some extent, within the adjacent Huckleberry Preserve stands. If the seed bank in this area, including that of the Huckleberry Preserve stands, has been genetically compromised though hybridization with non-native Arctostaphylos species, regeneration in the area could result in a hybrid swarm and a blurring of the genetic integrity of all future stands of A. pallida in the area. At this time, the extent to which hybridization has occurred and the extent to which hybridization threatens A. pallida is not known.

**Stressor:** Landscaping
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Arctostaphylos pallida plants that occur within the yards of private residences (less than 57 plants) in City of Oakland residential neighborhoods are highly susceptible to mortality from landscaping activities. The majority of these plants will likely be lost in the foreseeable future due to these activities and a lack of regeneration. In addition, the genetic integrity of the soil seed bank is questionable due to hybridization with non-native Arctostaphylos species (see Factor D, Hybridization above). Due to the susceptibility of these plants to mortality from landscaping and home improvement projects, and ongoing hybridization with non-native Arctostaphylos species, these plants and the associated seed bank will not contribute to meeting any of the recovery criteria for this species.

**Stressor:** Herbicide Use
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, herbicide use for the purpose of controlling roadside vegetation in the residential development adjacent Huckleberry Preserve was cited as a threat to Arctostaphylos pallida. Kanz (2004) indicated that A. pallida plants below the Pacific Gas and Electric Company power lines, between Manzanita Drive and Skyline Boulevard, exhibited evidence of herbicide use. Herbicide use continues to be a minor threat to A. pallida, particularly within the urban development and associated A. pallida stands adjacent to Huckleberry Preserve.

**Stressor:** Small Population Size and Stochasticity
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because Arctostaphylos pallida exists as three populations with only two large stands and several small satellite stands, inbreeding depression and stochastic events represent significant threats to the species. Inbreeding depression can result in reduced fitness, which, coupled with small population size may result in a higher susceptibility to stochastic events, such as excessive rain, drought, and landslides, that further increase the likelihood of loss of genetic variability. Stochastic events, such as prolonged rainy periods, can also increase susceptibility to other threats, such as fungal pathogens and Phytophthora cinnamomi.

**Stressor:** Climate Change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Effects to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and to what degree climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. The most recent literature

on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007).A modeling study by Loarie et al. (2008) provides an evaluation of potential trends to California’s floristic communities under climate change scenarios. In general, large numbers of plant species will tend to move to higher elevations, towards the coast, or northwards. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, Arctostaphylos pallida plants would likely be unable to shift their range naturally because of their dependence on specific soil types and a maritime climate and due to the presumably low dispersal potential of the species. Climate change may also affect summer fog frequency and have a substantial impact on Arctostaphylos pallida, which is dependent on a fog-influenced maritime climate. According to M. Vasey (personal communication 2010), coastal endemic Arctostaphylos species are more vulnerable to summer drought stress than interior species, and if the frequency of coastal fog declines, the hydrologic regime of coastal Arctostaphylos species will likely become more challenging as they are not well-adapted to water stress. In addition, summer fog increases plant, soil, and atmospheric moisture, which decreases fire hazard and decreases the threat of too-frequent fire. Based on observational (Bakun 1990, Lebassi et al. 2009) and modeling studies (Diffenbaugh et al. 2004, Snyder et al. 2003) climate change may intensify upwelling, an important process in fog production off the coast of California, suggesting increases in fog in response to increased carbon emissions. However, Johnstone and Dawson (2010) found empirical evidence for moderate fog reductions since 1951, with interannual and multidecadal variations governed largely by ocean-atmosphere circulation and temperature anomalies.

***Recovery***

**Reclassification Criteria:**
Not applicable

Recovery Priority Number: 5

**Delisting Criteria:**
To delist Arctostaphylos pallida, threats to the species habitat must be reduced. This will be accomplished when the following has occurred: The 6,700 mature Arctostaphylos pallida plants counted toward recovery in delisting criterion E/2 are protected from incompatible uses through long-term conservation agreements with landowners. To delist A. pallida, the threat of disease must be controlled or eliminated. This will be accomplished when the following have occurred: Tools or treatments have been developed and are effectively being utilized that have stopped the spread of Phytophthora cinnamomi and any individual mortality. Treatments have been developed that allow Arctostaphylos pallida plants infected with Phytophthora cinnamomi to produce viable seed during or after treatment in quantities similar to uninfected healthy A. pallida plants. A Phytophthora cinnamomi monitoring plan has been developed and implemented for all Arctostaphylos pallida stands and areas within watersheds of stands, to determine if stands are infected, the extent of infection, and to identify potential sources of future infection. Other natural or manmade factors believed to affect the continued existence of Arctostaphylos pallida include: fire frequency, wildfire fuel reduction treatments, succession and non-native invasive species, and small population size and stochasticity. To delist A. pallida, these threats must be reduced. This will have been accomplished when the following have

occurred: There are at least three separate populations of mature Arctostaphylos pallida plants: at least one population south of California State Route 24 (SR24) and at least two populations north of SR24, each with at least 1,700 genetically pure mature A. pallida plants.1 For the purpose of recovery, a population is considered to be separate as long as it is more than 3.0 kilometers (1.9 miles) from the nearest A. pallida stand, and a mature plant is defined as being 25 years of age or greater. There are at least 6,700 genetically pure mature Arctostaphylos pallida plants. Competing native and non-native vegetation is controlled to a level whereby Arctostaphylos pallida vigor is not negatively affected and landowners have committed to provide long-term vegetation control that will conserve resident A. pallida. Stand regeneration methods (mechanical or fire) result in an increasing trend in the number of mature Arctostaphylos pallida over a 25-year period. Seed, representative of the breadth of the species' genetic diversity, is stored at a seed storage facility.

**Recovery Actions:**

- In 2009, as part of a Low Effect Habitat Conservation Plan for EBMUD lands in the San Francisco East Bay, a large Pinus radiata that shaded the Pinehurst Road stand was removed. Prior to the removal of this tree, the stand had declined from 25 to 11 mature Arctostaphylos pallida plants. Apparently, the increased light not only invigorated the plants that had been shaded, but the mild disturbance to the site, caused by horse logging activities, stimulated a portion of the soil seed bank and over 52 A. pallida seedlings germinated. EBMUD continues to survey the Pinehurst Road stand on an annual basis.
- In the summers of 2004 and 2005, approximately 500 square feet (152 square meters) were cleared by EBRPD at Huckleberry Preserve, leaving only Arctostaphylos pallida plants. Cut material and dead wood were placed into piles. In late February and early March of 2007, the piles were burned. In 2008, 176 seedlings had sprouted within the burned area.
- The Big Trees Trail stand is likely to have sustained greater mortality if not for vegetation management activities conducted by a local volunteer watershed restoration organization, the Friends of Sausal Creek (FOSC). The FOSC conducts surveys of the site and occasionally removes both native and non-native plants that shade Arctostaphylos pallida plants. The management of the Big Trees Trail stand was included in the Chabot management plan to allow for a memorandum of understanding between FOSC and CDFG to permit FOSC to conduct restoration activities at both sites. A small number of A. pallida seeds have again germinated at the Big Trees Trail site in the absence of fire. Seed germination is likely due to soil disturbance caused by vegetation removal activities that scarified the seed coats.
- A 1995 Environmental Impact Report (EIR) prepared for the construction of the Science Center in Oakland California required that an A. pallida management plan be created and implemented. The plan was finalized in September 2009, and proposes to restore habitat and maintain a minimum of 21 plants at the site (Nomad Ecology 2009). According to the management plan, restoration activities were to begin in October 2009; however, the A. pallid at the Science Center have continued to decline and management activities did not begin until 2013.
- Recovery Strategy: Because Arctostaphylos pallida is an obligate-seeding species naturally occurring as even-aged stands with a long-lived soil seed bank, the primary management goal, at the stand level, should be to maximize seed production and to ensure the soil seed bank is adequate to replace all mature plants within a stand in the event of fire. At this time, the most significant long-term threats to seed production and stand regeneration, and in effect, the continued existence of the species, are: 1) the fungal pathogen Phytophthora cinnamomi which directly kills A. pallida plants and results in perpetual soil contamination;

2) competition, via succession, with native and non-native vegetation for light and space; 3) an altered fire regime that may prematurely deplete soil seed banks; 4) fire fuels management; and 5) small population and stand sizes that increase the likelihood stochastic events will extirpate a stand or population. In addition to ensuring habitat loss does not occur as a result of development, these threats can be minimized or ameliorated through the implementation of management plans that include and prioritize the control of P. cinnamomi at the stand level, P. cinnamomi spread abatement at the landscape level, management of competing native and non-native vegetation, perpetual stand regeneration, maintenance of genetic diversity, stand expansion, establishment of additional stands, and compatible fuel reduction treatments and methods.

- Phosphite (neutralized phosphorous acid), is a biodegradable systemic fungicide that, in part, potentiates plant defense mechanisms so that there is a more rapid and robust response to the pathogen. Phosphite stresses Phytophthora cinnamomi, causing it to release chemical signals that trigger the natural defense mechanisms of the host plant, thereby reducing the ability of P. cinnamomi to colonize and reproduce within the host (Suddaby and Liew 2008). Phosphite can be applied as a low volume aerial spray, high volume foliar spray, or by trunk injection of individual plants. The dosage of phosphite required to protect individual plant species is not universal. Applications that are too high for a particular plant species will have side-effects, such as leaf burning and a reduction in pollen viability, however, these effects may be temporary (Suddaby and Liew 2008). The efficacy of phosphite is not permanent and reapplication is required. The appropriate treatment regime (including an understanding of season, dose, application type, frequency, etc.) for Arctostaphylos pallida is not known at this time, but treatment frequency could be as often as once every 2 years. Low volume aerial application rates in Western Australia have ranged from 12 to 24 kilograms per hectare (11 to 21 pounds per acre) with disease control anticipated for approximately 2 years post-spray (Barrett et al. 2001). A study is currently underway to assess the efficacy of phosphite for limiting the spread of root disease caused by P. cinnamomi in native A. myrtifolia stands (Swiecki and Bernhardt, 2012).
- EBRPD's Wildfire Hazard Reduction and Resource Management Plan: According to EBRPD's Wildfire Hazard Reduction and Resource Management Plan (WHRRMP) the maritime chaparral vegetation type represents an extreme wildfire hazard. To reduce the hazard, the WHRRMP aims to focus mechanical fuel treatment efforts on key locations, including almost all stands of Arctostaphylos pallida. To minimize the effects of the WHRRMP, the Service is working with the Federal Emergency Management Agency and EBRPD to complete a long-term A. pallida management plan. Although the WHRRMP threatens A. pallida, the WHRRMP includes the removal of both native and non-native vegetation that grows within and adjacent to stands of A. pallida to reduce wildfire hazard. Shading by native and non-native species poses a significant threat to the existence of A. pallida (see Factor E section on Succession and Non-native Invasive Species); thus, the WHRRMP, if implemented in conjunction with an A. pallida management plan, may benefit the species.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct frequent surveys for Phytophthora cinnamomi infection to understand risk of infection and rate of mortality once infected. 2. Develop tools and treatments to control the spread and impact of Phytophthora cinnamomi. 3. Continue to use mechanical methods to clear over-shading trees, especially at the Big Trees Trail in Joaquin Miller Park colony and the Sobrante Ridge population. 4. Collect and store seeds from Tilden Park and Huckleberry Ridge populations, including accessions from each colony in the Huckleberry population. 5. At the Tilden Park, outplant seedling pallid manzanitas and scarify the ground to increase germination of latent seeds. 6. Partners and stakeholders should continue to promote Phytophthora cinnamomi education to the public to promote reduction of disease spread within and among the colonies (USFWS, 2023).

**References**

draft Recovery Plan

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Recovery Plans for the Pallid Manzanita and the Baker's Larkspur. Federal Register Vol. 80, No. 163, 51297-51298.

U.S. Fish and Wildlife Service. 2015b. Recovery plan for Arctostaphylos pallida (pallid manzanita). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi, + 39 pp.

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# SPECIES ACCOUNT: *Arenaria paludicola* (Marsh Sandwort)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/3/1993; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A herbaceous green perennial often supported by surrounding vegetation, with angled or grooved stems, which are glabrous (without hair) except at the nodes (points of leaf attachment) (Figure 1, Figure 3). The trailing stems often root at the nodes, and can be up to 1 meter (3 feet) long. The opposite leaves of the plant are lanceolate (lance-shaped) and narrowly acute (sharp-pointed), with a solitary mid-vein. The species blooms from May to August. At Oso Flaco Lake, it was flowering with some green fruit in early June (John Chesnut, in litt. 1998). Flowers are small, white, and borne singly on long stalks arising from the leaf axils (point of leaf attachment to the stem); capsules (fruits) contain 15 to 20 seeds. The solitary axillary flower and smooth, angled stem distinguish this species from others in the genus. Hitchcock (1964) speculated that this plant was “very seldom collected, possibly because it is mistaken for sterile plants of Galium aparine,” a common species. As reported by Bonilla (1992, in litt. 1998) from Zempoala Lakes in the state of Morelos in central Mexico, this species is an annual, flowering April to September and producing seeds from June to October. (USFWS, 1998)

**Taxonomy**

Marsh sandwort (Arenariapaludicola) is a dicotyledonous plant belonging to the pink family (Caryophyllaceae). Pertinent synonyms for the scientific name are Minuartia paludicola House; Alsinopsispaludicola A. Heller; Arenariapalustris S. Watson not of Gay 1845; and Alsine palustre Kellogg. The species first was described as Alsine palustre by Albert Kellogg in 1863, from specimens collected by Bolander near Fort Point (now within Golden Gate National Recreation Area), San Francisco, California. The plant was then “very abundant in swamps” in the area (Kellogg 1863). In 1876, Sereno Watson reassigned the species to the genus Arenaria. The resulting name, Arenaria palustris, inadvertently duplicated the name that Gay had published earlier, in 1845, for another species. This duplication of names was corrected by B.L. Robinson (1894), who substituted the currently used scientific name, Arenaria paludicola. (USFWS,1998)

**Historical Range**

Historically collected by botanists from scattered locations near the Pacific coast in southern and central California and Washington. California locations were recorded in 1899 in San Francisco and San Bernardino counties, in 1947 in Santa Cruz and San Luis Obispo counties, and in 1950 and 1964 in San Luis Obispo County. The southern range limit is given as Los Angeles County by Hitchcock (1964), and as the Santa Ana River (Orange County) by Hartman (1993). In a sequence of regional floras starting with Abrams and Ferris (1944), and continuing through Mason (1957), Munz and Keck (1968), Hoover (1970), Munz (1974), Smith (1976), and Hartman (1993), the earlier floras report the species as widespread within its historical range. Later floras report it as more localized and restricted, becoming “occasional,” “scarce” in swamps and marshes, and most recently, “rare.” (USFWS, 1998)

**Current Range**

In California, in San Luis Obispo County. One extant wild population at Oso Flaco Lake; one introduced population at Sweet Springs Marsh on the southern edge of Morro Bay. (USFWS,

2008)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, vegetative (USFWS, 2008)

**Breeding Season**

Adult: May - August (USFWS, 2008)

**Reproduction Narrative**

Adult: It generally blooms from May to August. This plant can also reproduce asexually. It can produce adventitious roots on the trailing stems that come in contact with suitable conditions (USFWS, 2008).

**Habitat Type**

Adult: Wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Freshwater marshes (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 0 - 450 m elevation (NatureServe, 2015); possibly shade (USFWS, 1998)

**Environmental Specificity**

Adult: Very Narrow (inferred from USFWS, 1998)

**Habitat Narrative**

Adult: Inhabits freshwater marshes from close to sea level to 450 m elevation. Plants have been found in areas with shallow standing water and with no standing water. Substrates are saturated, acidic, organic bog soils. Sensitive to disturbance; specialized habitat and wetlands are vanishing (NatureServe, 2015). Shady or filtered light conditions may inhibit the growth of Arenaria paludicola (USFWS, 1998).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Declining (most populations extirpated) (USFWS, 2008)

**Species Trends:**

Declining (USFWS, 2008)

**Number of Populations:**

2 (USFWS, 2020)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

Marsh sandwort was once a wide ranging species with a historic range that extended along the west coast from Washington State to Mexico (Service 2008, p. 5-6). The species distribution is now reduced to three isolated occurrences, with two populations at GGNRA in Marin County and two populations in San Luis Obispo County; at the Sweet Springs Nature Preserve on Morro Bay and Oso Flaco Lake on ODSVRA (Figure 1). Threats identified at the time of listing, in the 1998 Recovery Plan, and in the 2008 5-year review remain largely unchanged (Service 1993, 58 FR 41378; Service 1998, p. 8 and 18-21; Service 2008, p. 10-13). Climate change effects, especially those resulting in hydrological changes to marsh and other wetland habitats, are a new primary threat to the species. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2008).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There continues to be both a loss and degradation of habitat due to development/urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development/urbanization. Some of this habitat loss occurs in watersheds that are classified as impaired by the Regional Water Quality Control Board for excessive amounts of nitrogen and other nutrients (California State Water Resources Control Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (a state in which the total nitrogen is >1.5 milligrams/liter and/or the total phosphorus is >0.075 milligrams/liter within an aquatic system) (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998) (USFWS, 2008).

**Stressor:** Herbivory (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory has been documented in some locations. While this plant may be able to withstand some herbivory, herbivory may cause a reduction in its reproductive success due to the loss of flowers and the correlated reduction in the production of seeds. The extent of this threat is not known, but the herbivory of even a few flowers may have a significant effect on the long-term survival of Arenaria paludicola because there are so few individuals and only one known population remaining in the wild (USFWS, 2008).

**Stressor:** Small population size (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). An increase in urban development has reduced the range of this species considerably. Increasing development in the area will likely increase threats from stochastic events. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. The effects of competition with nonnative species is most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of A. paludicola independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of A. paludicola (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
1. When new plants are established so that there are at least 5 populations of at least 500 individuals each (USFWS, 1998)

2. When some of the populations occur in permanently protected habitats within the Black Lake Canyon and the dune lakes area (USFWS, 1998)

3. When some of the populations are in other areas of suitable habitat with the species' historical range in the United States (USFWS, 1998)

4. When the populations remain viable for at least 5 years. Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation(USFWS, 1998)

**Delisting Criteria:**
1. If threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management 5 necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) controlling competition with nonnative species, and b) managing water conditions, particularly flow and salinity, that the species depends on. (USFWS, 2019)

2. If protected populations are established across the species ecological settings (in addition to Black Lake Canyon and the Dune Lakes area), including San Mateo Creek in San Onofre State Park in Orange County or comparable site(s) in that region; the San Antonio Creek drainage on Vandenberg Air Force Base in Santa Barbara County or comparable site(s) in that region; and wetlands in Golden Gate National Recreation Area in San Francisco County or comparable site(s) in that region. (USFWS, 2019)

3) the populations remain viable for at least 10 years. Because this species has narrow microhabitat conditions that it will tolerate, particularly with respect to soil moisture and salinity, and in light of fluctuations that can occur with climatic conditions, local groundwater table levels, and saltwater intrusion events, the persistence of populations with these varying conditions over time needs to be confirmed. (USFWS, 2019)

**Recovery Actions:**

- 1. Protect, maintain, and enhance species habitats. The most important immediate objective in the recovery plan for and Marsh sandwort is the protection of its habitat. - Coordinate among agencies involved in recovery activities. - Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon. - . Establish protection agreements. - Acquire key land parcels and conservation easements. Enhance existing habitat at Black Lake Canyon. - Continue to protect, maintain, and enhance habitat in the Dune Lakes area. - . Communicate species and habitat protection information to all concerned parties. (USFWS, 1998)
- 2. Document and monitor population and habitat characteristics. - Conduct plant surveys. - Protect newly discovered populations. - Monitor all populations and habitats. (USFWS, 1998)
- 3. Conduct research on the ecology and biology of the species. - Identify potential impacts of conducting research. - Determine population characteristics and life history of the species. - valuate species' tolerances. - Investigate the effects of genetic diversity. (USFWS, 1998)
- 4. Augment existing populations. In addition to protecting existing and newly discovered habitats of Marsh sandwort , monitoring these populations and their habitats, and conducting research on the biology and ecology of the species, attempts should be made to augment existing populations. (USFWS, 1998)
- 5. Establish new populations. Because Marsh sandwort currently has very restricted distribution in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a catastrophic event could result in the extinction of the species with its current restricted distribution. (USFWS, 1998)
- 6. Evaluate Progress and Update Management and Recovery Guidelines. Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed. (USFWS, 1998)
- Work with the California Department of Parks and Recreation and other stakeholders to implement site-specific management activities in the immediate future to alleviate threats and prevent the loss of the last, known remaining wild population (at Oso Flaco Lake) (USFWS, 2008).
- Work with others to establish several new populations in the near future to reduce the risk of extinction to Arenaria paludicola and maintain ex situ stock at two or more institutions (USFWS, 2008).
- Assemble a scientific recovery implementation team to assist us in determining a scientifically sound plan to reintroduce and introduce Arenaria paludicola to sites within its historical range in California (USFWS, 2008).

- Work with the Regional Water Quality Control Board to determine nutrient levels in the watersheds which have supported Arenaria paludicola in the recent past (particularly Black Lake Canyon and Oso Flaco), and work with local landowners and stakeholders to alleviate (and remove) any threats to A. paludicola that are associated with water quality (USFWS, 2008).
- Conduct a genetic analysis to determine the extent of variation within and between Arenaria paludicola populations to help determine an appropriate recovery and reintroduction strategy (USFWS, 2008).
- Survey historical Arenaria paludicola sites for potential extant occurrences and to identify suitable sites for reintroductions and survey areas in southern and central California and near Tacoma in Washington State for potential new A. paludicola occurrences and to identify suitable sites for introductions (USFWS, 2008).
- Modify downlisting criterion number 4 ("[T]he [introduced] populations remain viable for at least 5 years") to viable onsite reproduction for more than one generation (i.e., a second, or "f2" generation) has been confirmed (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The following actions are recommended based on the current 5-year review: 1. Implement annual monitoring programs and develop comprehensive management plans to ameliorate the threats at extant populations. 2. Conduct surveys within suitable marsh habitats throughout the historic range and in extirpated sites previously known to have supported the species. 3. Conduct introductions at suitable sites that include long-term management strategies to ensure success and persistence of the species at introduced locations. 4. Continue to collect seed to expand the ex situ conservation seed bank collection. 5. Conduct research to evaluate site-specific effects of climate change, the role of sexual reproduction, the seed bank, and genetics of the species to inform management and introduction efforts. (USFWS, 2020)

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# SPECIES ACCOUNT: *Argemone pleiacantha* (Sacramento prickly poppy)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 08/24/1989; Southwest Region (Region 2) (USFWS, 2016)

**Physical Description**

Sacramento prickly poppy is a robust, short-lived perennial, 0.5-1.5 m (1.5-5.0 ft) tall with 3-12 branching stems and striking, blue-green colored leaves. The leaves are about 10.0-15.0 cm (4.0-6.0 in) long, with rectangular sinuses and spine-tipped lobes extending almost to the midrib. The veins and midrib are armored with stout, yellow spines. The large and showy white flowers have 6 petals 3.0-4.0 cm (1.2—1.6 in) long and 8.0-9.0 cm (3.5 in) wide, with numerous orange stamens and a purple stigma. Capsule spines are simple. The small, round, black seeds are 2.5 mm (0.1 in) in diameter and dispersed by wind, water and possibly animals (R. Galeano-Popp, U.S. Forest Service (USFS), pers. comm., 1992; R. Sivinski, New Mexico Energy Minerals and Natural Resources Department (NMEMNRD), in litt., 1992). In addition to the deeply divided leaves and simple capsule spines, Sacramento prickly poppy has white—colored stem sap. (USFWS, 1994)

**Taxonomy**

Recent molecular and geographic data (Cervantes et al., 2010) support a scientific name change for the Sacramento prickly poppy from Argemone pleiacantha spp. pinnatisecta to Argemone pinnatisecta, which was documented in the previous 5-year review for the poppy (USFWS, 2013). However, the scientific name has yet to be changed in the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) and associated recovery documents (USFWS, 2022).

**Historical Range**

The species' known historical range covered 13 canyons in 8 canyon systems of the Lincoln National Forest (LNF). Populations existed in Fresnal Canyon, including Salado and La Luz canyons; Dry Canyon; Marble Canyon; Alamo Canyon, including Caballero, Gordon, and Deadman canyons; Mule Canyon; San Andres Canyon; Dog Canyon; and Escondido Canyon (USFWS, 2022).

**Current Range**

Currently, poppies are known to be extant in 11 of these canyons. The species is also known to occur on Bureau of Land Management lands, private lands, Oliver Lee State Park, and on State of New Mexico and City of Alamogordo rights-of-way (USFWS, 2022).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: The flowers have a variety of pollinators that include carpenter bees (Xylocopa californica arizonensis), honey bees (Apis mellifera), bumblebees (Bombus ssp.), soldier beetles (Cantharidae), lizard beetles (Liguriidae), flies (Diptera), and butterflies (Lepidoptera) (U.S. Forest Service 2004). (USFWS, 2013)

**Breeding Season**

Adult: May through summer (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: Germination can only occur after cold stratification and is further enhanced if the seed coat is also scarified. (USFWS, 1994)

**Reproduction Narrative**

Adult: Generally, plants bloom during the second year, if moisture availability has allowed for sufficient growth. Flowering begins in May and continues throughout the summer depending on elevation and moisture conditions. The flowers have a variety of pollinators that include carpenter bees (Xylocopa californica arizonensis), honey bees (Apis mellifera), bumblebees (Bombus ssp.), soldier beetles (Cantharidae), lizard beetles (Liguriidae), flies (Diptera), and butterflies (Lepidoptera) (U.S. Forest Service 2004). Studies of pollination biology and subsequent fruit set and seed production show that prickly poppy will set little or no fruit unless visited by pollinators. Self pollination, either within one flower or among flowers of the same plant, results in significantly fewer fruits and fewer seeds per fruit (Tepedino 1992). Seed output for mid- sized plants in Alamo and Dog canyons averaged about 2,000 seeds per plant (Malaby 1988). However, based on nursery results, seed germination is low (approximately 3 percent in 1989) and seedling mortality is high (Malaby 1988). Germination can only occur after cold stratification and is further enhanced if the seed coat is also scarified. (USFWS, 1994; USFWS, 2013)

**Habitat Type**

Adult: Terrestrial and palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Riparian, desert, forest/woodland, woodland- conifer (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations between 4,200 and 7,120 feet (USFWS, 1994)

**Environmental Specificity**

Adult: Medium, with some key requirements (USFWS, 1994)

**Tolerance Ranges/Thresholds**

Adult: High (USFWS, 1994)

**Habitat Narrative**

Adult: Sacramento prickly poppy is found in the dry hills, pinyon-juniper zone (Flora of North America Editorial Committee 1997) on loose, gravelly soils of open disturbed sites, canyon bottoms and slopes (McDonald 2010). Usually in areas of enhanced soil moisture such as north-facing slopes, canyon bottoms, along drainages, and near leaks in water pipelines. Sacramento prickly poppy occurs in rocky canyons on the western slope of the Sacramento Mountains. It ranges from 4,200 feet elevation in the lower Dog Canyon area to 7,120 feet elevation in upper Alamo Canyon area (Malaby 1987). The topography of the area is characterized by steep, rocky hillsides. Soils are primarily derived from limestone and may also contain sandstone and gypsum (USFS 1992). Numerous large canyons and arroyos drain westward into the Tularosa Basin. Annual precipitation in the Sacramento Mountains averages about 38 cm (15 in) per year, most of which occurs from July through October, during brief but heavy thundershowers (U.S. Soil Conservation Service (SCS) 1981). All canyons on the west side of the Sacramento Mountains experience periodic and severe flash floods (USFS 1992). Wide fluctuation in diurnal and seasonal temperatures is characteristic of the western slope of the Sacramento Mountains. Temperatures average above 90 degrees Fahrenheit from mid—May to mid— September and may go as low as 16 degrees Fahrenheit during the winter (SCS 1981). High temperatures combined with high insolation and high evaporation rates create xeric conditions in the western foothills of the Sacramento Mountains (NMNP PAC 1984). Unlike seedlings, established poppy plants appear to be capable of weathering periods of drought by becoming dormant. (USFWS, 1994; USFWS, 2013)

***Dispersal/Migration***

**Dispersal**

Adult: Medium (USFWS, 1994)

**Dispersal/Migration Narrative**

Adult: The small, round, black seeds are 2.5 mm (0.1 in) in diameter and dispersed by wind, water and possibly animals (R. Galeano—Popp, U.S. Forest Service (USFS), pers. comm., 1992; R. Sivinski, New Mexico Energy Minerals and Natural Resources Department (NMEMNRD), in litt., 1992). The majority of Sacramento prickly poppy seeds do not travel far from the parent plant and would remain there if flash floods did not move these large and heavy seeds downslope through the canyon drainage channels. This large endosperm could be a potential source of food for various rodents, birds, and insects. Dispersal by animals to upland sites may account for the occasional presence of prickly poppy plants in areas away from drainages. Soreng (1982) observed ants transporting seeds. (USFWS, 1994)

***Population Information and Trends***

**Population Trends:**

Decline of 62% over 23 years (USFWS, 2022)

**Number of Populations:**

9 (NatureServe, 2015)

**Population Size:**

~1,000 (NatureServe, 2015)

**Population Narrative:**

Long-term population trends suggest a decline of 30 to 50%. Approximately 1,286 total plants of Sacramento prickly poppy occupy 10 canyons on the western slope of the Sacramento Mountains in south—central New Mexico. In the late 1980's, there were approximately 1300 plants (McDonald 2010). More recently, the total number of plants is estimated to be below 1000 (Sivinski 1999; Tonne 2008 cited by Cervantes et al. 2010). (USFWS, 1994; NatureServe, 2015) Little new information is available on this species' population trend since the previous 5-year review was completed in 2013 (USFWS, 2013). New data on the poppy was provided by the LNF and included survey data that were collected from 2013 to 2019. These data show that counts of adult prickly poppy in Alamo and Caballero canyons have fluctuated each year but remained relatively static between 2016 and 2019. While the most current survey data do not show as steep of a decline as was documented in the last 5-year review (62 percent over 23 years; USFWS, 2013), the species still appears to be declining in the number of adults at sites that were surveyed. The surveys conducted did not document many seedling or sub-adult poppies, which may indicate that recruitment is not occurring or some unknown threat is affecting adult poppy reproduction ability. Alternatively, the apparent lack of recruitment could be associated with difficulties in locating seedlings, especially in areas that other vegetation is dense, resulting in under reporting of seedling and sub-adult poppies. Since the last 5-year review, survey efforts have occurred sporadically and advantageously across known poppy sites rather than systematically across all poppy sites. Inconsistent survey of poppy sites makes it difficult to determine if poppies are persisting at all previously known sites, if these populations are remaining relatively static as seen in Alamo and Caballero canyons, or if a population may have been extirpated from some sites. In 2018, data were collected in 6 canyons, indicating that the species continues to persist at these locations, though two sites had less than 5 individuals and no documentation of recruitment. Only Alamo and Caballero canyons were re-surveyed in 2019 (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Flooding (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Flooding and erosion are known threats to the poppy (Soreng 1982; U.S. Fish and Wildlife Service 1989, 1994, 2004, 2012; Sivinski 1992; Forest Service 2004; Tonne 2008). In 1977, severe floods were observed to remove up to 100 plants from lower Alamo Canyon (Fletcher 1978; Soreng 1982). Two years later, when Fletcher found only six plants in this location in 1979, he speculated that the population might be in jeopardy of extirpation. Observations since this time have shown that plants in and along arroyos are subject to periodic damage and loss of mature plants from floods, and numbers fluctuate considerably in response to flooding. Some plants are completely removed or buried by floods, and others re-sprout from roots (Tonne 2008). Recent floods have had severe, damaging effects to individual poppy plants, but long-term impacts to populations are unknown (U.S. Forest Service 2008). (USFWS, 2013)

**Stressor:** Livestock (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Grazing and trampling by livestock can destroy young seedlings and can potentially degrade the quality of poppy habitat. Livestock grazing can affect vegetation species composition, plant density, and plant vigor. Cattle tend to occupy canyon bottoms, where poppy seedlings are most likely to occur, because the steep sides of the canyon render most of the

acreage in the pasture inaccessible. Out of the approximately 11,000 acres on the Alamo winter pasture, only about 3,000 acres are usable and accessible to livestock. Livestock may avoid eating most mature poppy plants due to their bitter-tasting latex; however, early season basal rosettes with spines have been grazed to the ground (Forest Service 2005). Detrimental effects to the poppy depend on the timing, intensity, and duration of livestock use. Trampling by cattle has been more frequently observed than herbivory, especially of adult plants. Herbivory by livestock appears to occur mostly during periods of drought, but trampling by livestock can impact the poppy at any time (Salas and Barker 2003; Tonne 2008). Healthy mature plants appear to be capable of re-sprouting after livestock tread on them, but mortality appears likely to occur in young plants or in stressed mature plants suffering from drought or disease. At higher stocking rates, the threat of seedling mortality is greatly increased because livestock have a direct negative impact on the poppy when their presence coincides with the emergence of seedlings (Soreng 1982; Wagner and Sabo 1982; U.S. Fish and Wildlife Service 1989, 1994, 2005, 2008, 2012; Wood 1992; Salas 2003). The period between germination and establishment of the mature poppy is the most vulnerable time in this plant’s life cycle. This developmental stage is the main impediment to increased abundance in any colony or population of this taxon. Germination has been documented throughout the range of the poppy, sometimes in great abundance. However, as with many plants, few of these seedlings survive to become reproductive adults. Some are killed almost immediately through trampling by livestock, while others face periods of dry weather, flooding, or other disturbance. Rotation dates have sometimes been violated, and cattle have remained in poppy habitat year-round, causing damage to poppy seedlings and likely contributing to poor watershed condition through the reduction of herbaceous and riparian vegetation (Tonne 2008, U.S. Forest Service 2008). (USFWS, 2013)

**Stressor:** Herbicide spraying (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In 2007, herbicide was sprayed by the New Mexico Department of Transportation on U.S. Highway 82 near High Rolls, New Mexico, to reduce vegetation in the right-of-way. The herbicide was applied directly to at least five adult poppies, killing three of these. The Forest Service flagged areas that should not be sprayed, but this did not successfully protect the plants. The use of flagging does not appear to be adequate because, at best, it protects only adults known to the Forest Service employee deploying the flagging. It does not protect seedlings or young plants, or adults that are hidden from view (Tonne 2008). Due to this event, the New Mexico Department of Transportation has not sprayed herbicide in poppy habitat again. An agreement to improve protection of poppies from this activity has been discussed among the New Mexico Department of Transportation, U.S. Forest Service, and U.S. Fish and Wildlife Service. (USFWS, 2013)

**Stressor:** Road maintenance (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** During spring 2008, the City of Alamogordo cleared a maintenance road in upper Alamo Canyon, destroying many mature poppies (U.S. Forest Service 2008). During a survey in June 2008, only a few poppies had re-sprouted in this area. Some poppies that were previously

located in or adjacent to the roadway were missing and presumed dead, but a few had re-sprouted in the road (U.S. Fish and Wildlife Service 2008). (USFWS, 2013)

**Stressor:** Water extraction (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The City of Alamogordo captures water at the head of Alamo, Caballero, Fresnal, and La Luz canyons, potentially reducing the amount of water available to the poppy. Because poppy seedlings are delicate and sensitive to drying until they establish their taproot, any factor that increases soil dryness is likely to affect seedling establishment and recruitment. This permanent removal of water at headwater springs under State water rights by local communities, combined with livestock presence, drought, and climatic fluctuations have degraded riparian and spring habitat (U.S. Forest Service 2003, 2008; Tonne 2008). These relatively mesic areas within the range of the poppy may have historically served as important reserves during periods of drought. (USFWS, 2013)

**Stressor:** Road and pipeline construction, maintenance (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road and pipeline construction and maintenance activities sometimes destroy poppy plants. The Lincoln National Forest performs road maintenance on approximately 523 km (325 mi) of roads per year. Additional maintenance is conducted on Federal, State, and county non-National Forest System roads (U.S. Forest Service 2004). In Fresnal Canyon, road maintenance by the Otero County Road Maintenance Department resulted in the loss of poppy plants along an unpaved National Forest System road. In Fresnal Canyon, road maintenance by the Otero County Road Maintenance Department resulted in the loss of poppy plants along an unpaved National Forest System road. During spring 2008, the City of Alamogordo cleared a maintenance road in upper Alamo Canyon, destroying many mature poppies (U.S. Forest Service 2008). Surveys in June 2008, reported that only a few poppies had re-sprouted. Many poppies that were previously located in or adjacent to the road were missing and presumed dead (U.S. Forest Service 2008). The loss of plants in the upper reaches of occupied habitat leads to reductions in seed dispersal from this area to existing colonies and potential new habitat downstream. The City of Alamogordo maintains water pipelines that tap large springs on the upper western slope of the Sacramento Mountains. These pipelines occur in La Luz, Fresnal, Alamo, and Caballero Canyons. The water rights for these systems pre-date the Lincoln National Forest. The pipelines in Alamo, Caballero, and Fresnal Canyons, canyons occupied by poppy, have been replaced over time as the pipes become cemented in with calcium carbonate. The new pipelines no longer leak water along their route through the canyon bottoms, as they historically have, and, consequently, no longer provide water to limited areas that may have supported poppies in the past (U.S. Forest Service 2004). Municipal use of canyon water has changed the natural hydrology, making upland areas and canyons much drier, perhaps reducing poppy habitat. Pipeline repair, replacement, and maintenance are ongoing in four canyons. These pipelines and associated activities continue to impact the suitability of poppy habitat. Heavy equipment used to transport, excavate, position, and remove large sections of steel pipe may damage or destroy plants if not carefully controlled and monitored. The Forest Service has surveyed, consulted upon, and monitored these activities when informed of them in advance (U.S. Fish and Wildlife

Service 2008). (USFWS, 2013)

**Stressor:** Mowing and herbicide application along roadways (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Roadway maintenance, including herbicide use and mowing, may threaten the poppy. Although the poppy is adapted to disturbed habitats, and, therefore, could benefit from some ground-disturbing activities, blading along drainage ditches and the shoulders of unpaved roads has destroyed some poppy plants (U.S. Forest Service 2004). Invasive plants such as Russian thistle, tamarisk, spotted knapweed, and Russian knapweed occur in poppy habitat. At present, the Forest Service and New Mexico State Highway and Transportation Department coordinate efforts at weed control and implement spraying of infested sites along the highways. Because plant competition may be a limiting factor to the distribution of the poppy based on the poppy's preference for sites that are more open and less densely vegetated, eliminating invasive plants may be beneficial for the poppy (U.S. Fish and Wildlife Service 1994). However, any spraying performed near poppy individuals still may pose a threat to the survival of this species. Direct and indirect application of herbicides on poppies in 2007 resulted in loss of plants occurring along the Highway 82 corridor (Tonne 2008). Since this occurrence, the New Mexico State Highway and Transportation Department has ceased spraying herbicides in proximity to poppy plants. In addition, the Lincoln National Forest has completed consultation on their Noxious Weed Control Plan for treatments of noxious weeds in the vicinity of the poppy. (USFWS, 2013)

**Stressor:** Off-highway vehicles (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-highway vehicles are recognized to be a potential threat to the poppy. Off-highway use of motorized vehicles on established trails is permitted in Alamo, Caballero, and Dry canyons on the Lincoln National Forest. Dry Canyon is not currently occupied by the poppy, and the mouth and only western access route into Alamo and Caballero canyons through City of Alamogordo land is closed to motorized traffic. Unauthorized off-highway vehicles can crush individual poppy plants and threaten the health of poppy habitat. Off-highway vehicles can destabilize or compact soils, which affect seed germination and plant growth. Motorized travel is prohibited on the Forest beyond 91 meters (m) (300 feet [ft]) from a road, except for purposes of camping or parking. This excludes use in the channels of Fresnal and La Luz canyons on National Forest System lands. Offhighway vehicles can crush or disturb poppy individuals and may modify the soils, local hydrology, and microclimates associated with seed germination and plant growth (U.S. Forest Service 2004). Furthermore, the creation of trails through poppy habitat can promote the spread of noxious weeds already present in the area (U.S. Forest Service 2004) into these areas which may threaten the poppy's establishment through competition. As an indication of increased interest in off-road riding in poppy habitat, a website exists that provides advice on how to circumvent Lincoln National Forest closures and lists detours to take in the vicinity of Alamo Canyon. Off-highway vehicles present a moderate threat to the poppy at this time. (USFWS, 2013)

**Stressor:** Fungal mold (USFWS, 2013)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** The presence of Alternaria sp., a fungal mold that can be a plant pathogen, has been observed to be an intermittent problem throughout the distribution of the poppy (Tonne 2005). For example, this fungal stem canker caused 7 of 18 plants to fail to set fruit and subsequently die in Dog Canyon (Sivinski 1999). It appears to be most common and damaging in drought years (Tonne 2008). A link between decreased water availability and increased cases of disease may exist, as drying may weaken a plant's resistance to disease. (USFWS, 2013)

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Global climate change may be a threat to the poppy in the foreseeable future. The global average temperature has risen by approximately 0.6 degrees Celsius during the 20th Century, according to the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change 2001, 2007). Warming temperatures have been documented in recent decades in the southwestern United States. In New Mexico, mean annual temperature has increased by 0.6 degree per decade beginning in 1970, and warming is greatest in spring (Lenart 2005). Higher temperatures lead to higher evaporation rates which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge (Stewart et al. 2004). Temperature changes and seasonal shifts may stimulate earlier growth in the spring or extend the growing season into the fall that is out of phase with available moisture, possibly leading to increased water stress and decreased survival for the poppy. Flowering phenology may also be affected by temperature shifts, potentially causing asynchronous relationships with pollinators and reducing chances of sexual reproduction for the plant. In recent years, the area occupied by the poppy has been under severe drought. These precipitation levels led to low soil moisture conditions that severely curtailed recruitment of poppies into the population (U.S. Fish and Wildlife Service 2004a; Tonne 2008). From 2008 continuing through to the present, the Palmer long-term drought severity index for Otero County has been primarily in the severe to extreme range (National Oceanographic and Atmospheric Administration 2008-2013). Thus climate change presents a significant threat to the poppy, with impacts likely from not only precipitation and temperature changes, but also from possible interactive effects with grazing, water extraction, and disease. (USFWS, 2013)

**Stressor:** Small population size and low genetic diversity (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Decreasing genetic diversity is an indirect threat capable of extirpating the limited populations of poppies. Populations composed of smaller numbers of plants with narrow distributions are more susceptible to elimination from stochastic events, such as flooding or drought, or demographic fluctuations, such as reduced numbers of adults or diminished seed banks, than are larger, more widely distributed populations. A loss of populations or individuals may contribute significantly to a reduction in the gene pool and the ability of the species to adapt to environmental changes. With fewer, more widely spaced plants, out-crossing may become more difficult, which Tepedino (1992) has shown reduces fruit and seed set and could preclude population recovery. At this time, the small population size and limited genetic diversity present

a minor threat to the Sacramento prickly poppy. (USFWS, 2013)

***Recovery***

**Reclassification Criteria:**

The Sacramento prickly poppy will be considered for downlisting when: 1. The Alamo-Caballero Canyon population is shown to be stable or improving over a 20- year period with at least 1,000 individuals (flowering adults) according to the following measures: a) The Alamo-Caballero Canyon population has been designated as the core recovery population. The Alamo-Caballero Canyon population includes all individuals (flowering adults) located with these two canyon systems. This core population will be monitored yearly using annual demographic trend monitoring at representative sites to provide a population estimate based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. b) Approximately every 5 years, range wide and peripheral counts within Alamo and Caballero Canyons will be conducted using standardized methods peer-reviewed by species experts and approved by the Service. c) Species presence and abundance is maintained at the aforementioned level within the core Alamo-Caballero Canyon population. The population shall be considered stable when a linear regression analysis (or other method which has been peer-reviewed by species experts and approved by the Service) of the population numbers estimated from the results of annual demographic monitoring reveals no significant decline in numbers. d) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain a resilient population. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. (USFWS, 2019)

2. The 7 additional canyon systems (outside of Alamo-Caballero Canyon), which represent the currently-known occupied habitat for the Sacramento prickly poppy, are shown to maintain stable or improving occupancy over a 20-year period with at least 50% of the canyons demonstrating an average of 75% probability of occupancy over this time frame, according to the following measures: a) Maintain or increase occupied and high probability of occupancy habitat within these canyon systems. b) These additional canyon systems will be surveyed at least once every 2 years utilizing annual occupancy monitoring at representative sites within each canyon to provide a probability of occupancy for the canyon based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. c) Occupancy is maintained at 75% probability of occupancy within at least 50% of the additional canyon systems. The canyon systems shall be considered stable when occupancy analysis based on methodology peer-reviewed by species experts and approved by the Service reveals no significant decline in occupancy. d) As well as demonstrating no significant decline in occupancy, each canyon system should maintain functionality over the 20-year period with appropriate demonstrated population dynamics as defined by methodology peer-reviewed by species experts and approved by the Service. e) Approximately every 5 years, efforts to characterize occupied and high probability of occupancy habitat throughout the canyon systems

should be conducted based on methodology peer-reviewed by species experts and approved by the Service. f) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain resiliency across these additional populations. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. (USFWS, 2019)

3. The genetic corridors between populations are maintained through patterns of occupancy within different canyon systems to promote gene transfer as defined by methodology peer-reviewed by species experts and approved by the Service. (USFWS, 2019)

4. The Alamo/Caballero Canyon populations, as well as populations within additional canyon systems considered occupied habitat, must be protected through the development and implementation of species-specific management recommendations that protect the species from identified threats (e.g., livestock grazing and water extraction). a. These management recommendations should be developed in coordination with the Service and implemented by the appropriate land management entity (entities). b. These management recommendations should be periodically evaluated (i.e., at least every 2 years) to ensure effectiveness and success in protecting the species from identified threats. (USFWS, 2019)

Recovery Priority Number: 5C

**Delisting Criteria:**
1. The Alamo-Caballero Canyon population is shown to be stable or improving over a 20- year period with at least 1,500 individuals (flowering adults) according to the following measures: a) The Alamo-Caballero Canyon population has been designated as the core recovery population. The Alamo-Caballero Canyon population includes all individuals (flowering adults) located with these two canyon systems. This core population will be monitored yearly using annual demographic trend monitoring at representative sites to provide a population estimate based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. b) Approximately every 5 years, range wide and peripheral counts within Alamo and Caballero Canyons will be conducted using standardized methods peer-reviewed by species experts and approved by the Service. c) Species presence and abundance is maintained at the aforementioned level within the core Alamo-Caballero Canyon population. The population shall be considered stable when a linear regression analysis (or other method which has been peerreviewed by species experts and approved by the Service) of the population numbers estimated from the results of annual demographic monitoring reveals no significant decline in numbers. d) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain a resilient population. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve

a resilient population, if necessary. The recovery criteria would be reassessed to establish more appropriate population numbers, if necessary. (USFWS, 2019)

2. The 7 additional canyon systems (outside of Alamo-Caballero canyon) which represent occupied habitat for the Sacramento prickly poppy are shown to maintain stable or improving occupancy over a 20-year period with at least 75% of the canyons demonstrating an average of 75% probability of occupancy over this time frame, according to the following measures: a) Maintain or increase occupied and high probability of occupancy habitat within these canyon systems. b) These additional canyon systems will be surveyed at least once every 2 years utilizing annual occupancy monitoring at representative sites within each canyon to provide a probability of occupancy for the canyon based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. c) Occupancy is maintained at the aforementioned levels within the additional canyon systems. The canyon system shall be considered stable when occupancy analysis based on methodology peer-reviewed by species experts and approved by the Service reveals no significant decline in occupancy. d) As well as demonstrating no significant decline in occupancy, each canyon system should maintain functionality over the 20-year period with appropriate demonstrated population dynamics as defined by methodology peer-reviewed by species experts and approved by the Service. e) Approximately every 5 years, efforts to characterize occupied and high probability of occupancy habitat throughout the canyon systems should be conducted based on methodology peer-reviewed by species experts and approved by the Service. f) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain resiliency across these populations. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. (USFWS, 2019)

3. Genetic diversity is maintained within the core Alamo/Caballero canyon population, and throughout populations within canyon systems which are considered occupied habitat, according to the following measures: a) The weak genetic divergence that has been observed between populations found in different canyon systems is maintained at a sufficient level to avoid any potential outbreeding depression as defined by methodology peer-reviewed by species experts and approved by the Service. b) The genetic corridors between populations are maintained through patterns of occupancy within different canyon systems to promote gene transfer as defined by methodology peer-reviewed by species experts and approved by the Service. (USFWS, 2019)

4. The existing species-specific management recommendations (developed in coordination with the Service and implemented by the appropriate land management entity/entities) have been effective and successful in protecting the species over the 20-year period required to reach the delisting criteria described above. In addition, all land managing agencies have developed a Post-Delisting Monitoring Plan (which has been approved by the Service's Southwest Regional Director) to cover a minimum of 5 years post-delisting of the species and are prepared to implement this plan prior to delisting to ensure the ongoing conservation of the listed species

and the continuing effectiveness of management actions. a) In addition to this criterion, monitoring and research have been completed to conclude with a high degree of certainty that population sizes, quality, configuration, and management are adequate to provide a high probability of species survival (greater than 90 percent over 100 years). (USFWS, 2019)

**Recovery Actions:**

- Study biological and habitat requirements of the species. (USFWS, 1994)
- Develop a management plan for the City of Alamogordo's water pipeline project in the Alamo and Fresnal Canyon systems with measures to avoid or reduce impacts to populations. (USFWS, 1994)
- Develop a management plan with the Lincoln National Forest and the Bureau of Land Management for Sacramento prickly poppy plants located on lands under their jurisdiction. Conduct long-term monitoring studies to evaluate the impacts of livestock grazing and trampling, and off-road vehicles on these populations. (USFWS, 1994)
- Develop a management plan with the New Mexico State Highways and Transportation Department for populations occurring in the Highway 82 right-of-way and any other plants affected by their management. (USFWS, 1994)
- Develop a conservation agreement with private landowners to protect plants on private property. (USFWS, 1994)
- Conduct surveys in potential habitat. (USFWS, 1994)
- Study biological and habitat requirements of the species. (USFWS, 2013)
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- Develop a management plan with the Lincoln National Forest and the Bureau of Land Management for Sacramento prickly poppy plants located on lands under their jurisdiction. Conduct long-term monitoring studies to evaluate the impacts of livestock grazing and trampling, and off-road vehicles on these populations. (USFWS, 2013)
- Develop a management plan with the New Mexico State Highways and Transportation Department for populations occurring in the Highway 82 right-of-way and any other plants affected by their management. (USFWS, 2013)
- Develop a conservation agreement with private landowners to protect plants on private property. (USFWS, 2013)
- Conduct surveys in potential habitat. (USFWS, 2013)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Establishing a specific survey protocol, methodology, and monitoring schedule to document population trends and gain an accurate assessment of population size and extent would be beneficial for the poppy. Additionally, threats that could be managed through landowner action such as livestock herbivory and water development/diversion should be reduced to the maximum extent practical and monitored to determine existing and on-going impacts to the Sacramento prickly poppy and its habitat. A species status assessment to inform a recovery plan revision should, when workload permits, be conducted to incorporate new information on the species. Research is needed to better understand best practices that would support restoring the poppy throughout its range and to identify habitat requirements of the species. This research should include analyzing the long-term viability of the poppy to determine if inbreeding depression or other factors may exist that are limiting poppy fecundity and recruitment and develop management recommendations that could prevent the continued decline in poppy population size and resilience. Investigation is also needed to determine if the acquisition of water rights under the existing water rights law established by the state of New Mexico is possible to protect habitat for the Sacramento prickly poppy (USFWS, 2022).

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# SPECIES ACCOUNT: *Argythamnia blodgettii* (Blodgett's silverbush)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/31/2016; Southeast Region (R4)

**Physical Description**

Argythamnia blodgettii, in the Euphorbia family, is an erect, perennial shrub or herb, 10 to 60 cm (4 to 24 in) tall, with a woody base and small, green flowers. The stems and leaves are covered with small hairs. The leaves, arranged alternately along the stems, are 1.5 to 4.0 cm (0.6 to 1.6 in) long, have smooth (or rarely toothed) edges, are oval or elliptic in shape, and often are colored a distinctive, metallic bluish green. The plants have separate male and female flowers. Staminate (male) flowers have a calyx 7 to 8 mm (0.27 to 0.31 in) wide, consisting of 4 to 5 lanceshaped sepals that are larger than the petals. The petals are broadly elliptic and shorter than the sepals. There are 10 stamens. Pistillate (female) flowers have 4 to 5 sepals that are 5 to 6 mm (0.19 to 0.24 in) long, lance-shaped, and often more narrow than those of male flowers. The petals are broadly elliptic, shorter than the sepals. The fruit is a woody capsule 4 to 5 mm (0.16 to 0.19 in) wide, which contains the seeds (Adapted from Small 1933, pp. 784–785; Bradley and Gann 1999, p. 2). (USFWS, 2015)

**Taxonomy**

Botanist John Torrey first described the species in Chapman (1884, p. 100) as Aphora blodgettii, reporting it for South Florida. In an 1896 (p. 100) revision of the genus, Pax placed it in the genus Ditaxis. In 1897 (p. 100), Chapman placed it in the genus Argythamnia. In 1903, Small placed it again in the genus Ditaxis. In 1914, Pax (p. 100) placed it in synonymy under Ditaxis fendleri, a plant of Colombia, Venezuela, Curacao, and Trinidad. Small (1933, pp. 784–785) retained it as Ditaxis blodgettii, treating it as a southern Florida endemic. Subsequent authors (Webster 1967, p. 100; Long and Lakela 1971, p. 558; Wunderlin 1998, p. 100; Wunderlin and Hansen 2003, p. 100) have retained it as a southern Florida endemic Argythamnia blodgettii (from Hodges and Bradley 2006, p. 10). The Integrated Taxonomic Information System (2015, p. 1) uses the name Argythamnia blodgettii and indicates that this species' taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name A. blodgettii. In summary, there is consensus that A. blodgettii is a distinct taxon. We have carefully reviewed the available taxonomic information to r each the conclusion that the species is a valid taxon. Synonyms include Aphora blodgettii Torr. ex Chapm.; Ditaxis blodgettii (Torr. ex Chapm.) Pax; Argyrothamnia blodgettii (Torr. ex Chapm.) Chapm.; and Ditaxis fendleri Pax, not (Mull. Arg.) Pax and K. Hoof. (USFWS, 2015)

**Historical Range**

U.S., Florida, Miami-Dade and Monroe counties. Argythamnia blodgettii historically occurred from central and southern Miami-Dade County from Brickell Hammock to Long Pine Key in Everglades National Park, and in Monroe County throughout the Florida Keys from Totten Key south to Key West (Bradley and Gann 1999, p. 2) (USFWS, 2015).

**Current Range**

U.S., Florida, Miami-Dade County. Argythamnia blodgettii is currently known from central Miami-Dade County from Coral Gables and southern MiamiDade County to Long Pine Key in Everglades National Park, and the Florida Keys from nine islands, from Windley Key (Bradley and

Gann 1999, p. 3) southwest to Boca Chica Key (Hodges and Bradley 2006, pp. 10, 43) (USFWS, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2015)

**Breeding Season**

Adult: Flowering and fruiting take place throughout the year (USFWS, 2015).

**Other Reproductive Information**

Adult: Perennial (USFWS, 2015)

**Reproduction Narrative**

Adult: Reproduction is sexual; flowering and fruiting apparently takes place throughout the year (Bradley and Gann 1999, p. 3) (USFWS, 2015).

**Habitat Type**

Adult: Low, moist limestone areas near margins of pine rocklands. Sunny edges and gaps in pine rocklands, rockland hammocks, and coastal berm (USFWS, 2013).

**Habitat Vegetation or Surface Water Classification**

Adult: Forest/Woodland, Woodland - Conifer (USFWS, 2013)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: Argythamnia blodgettii grows in pine rocklands, in sunny gaps or edges of rockland hammock and coastal berm, and on roadsides (Bradley and Gann 1999, p. 3). It grows from crevices on oolitic limestone or on sand. The pine rocklands habitat where it occurs requires periodic fire to maintain an open, sunny understory with a minimum amount of hardwoods. Bradley and Gann (1999, p. 3) indicated that this species does tolerate some degree of human-induced disturbance. It can often be found along disturbed edges of pine rocklands, rockland hammock, and coastal berm, or in completely scarified pine rocklands (Bradley and Gann, 1999, p. 3) (USFWS, 2015).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2023)

**Number of Populations:**

55 Populations (26 extant, 15 uncertain, and 14 extirpated) (USFWS, 2023)

**Population Size:**

~21,000 total (USFWS, 2023)

**Population Narrative:**

At the time of listing, Blodgett's silverbush had been documented in 50 populations (20 extant, 15 uncertain, and 15 extirpated) in Miami-Dade and Monroe Counties (Service 2016). However, several of these populations are near each other, within NatureServe's (2020) 0.62-mile (1.0-kilometer [km]) distance to differentiate populations but occur on separate parcels or lands with different ownership and were thus treated as separate populations in the listing rule. The Service now uses NatureServe's (2020) 0.62-mile (1.0-km) distance to delineate populations. Therefore, populations in the listing rule (Service 2016) that are within 0.62 miles (1.0 km) of each other are now combined into single populations with subpopulations (Appendix A). Also, the Big Pine Key/National Key Deer Refuge population reported in the listing rule (Service 2016) has been split into three separate populations based on their distances of over 0.62 miles (1.0 km) apart. In the listing rule (Service 2016), we considered a population to have an uncertain status if it had not been surveyed in 15 or more years and extirpated if the plants were not seen during a survey or if the habitat had been destroyed. However, we have no quantitative information on how long Blodgett's silverbush seeds may persist in the soil seed bank (Service 2015), and observations from Fairchild botanists indicate they may form persistent soil seed banks (Wintergerst 2023). Therefore, in this review, we are considering a population or subpopulation extirpated if the habitat is developed or there is a negative survey more than five years old with a small (>100) or unreported number plants in the previous survey. A population or subpopulation is considered to have uncertain status if it has a negative survey within five years with presence recorded previously and habitat remaining or has not been observed in more than 15 years with presence recorded previously and habitat remaining. A population or subpopulation is considered extant if it has been observed on site in the previous 15 years. Using this new population delineation and updated status categorization, we recognize 55 populations (26 extant, 15 uncertain, and 14 extirpated) in MiamiDade and Monroe Counties (Table 1; Appendix A). This difference in population delineation reflects a reduction in the number of populations due to combining several from the listing rule, but also an increase from splitting the Big Pine Key/National Key Deer Refuge population into three separate populations. In addition to these delineation changes, the number of populations has increased due to five newly discovered populations, five population introductions, and four populations that were not reported in the listing rule (Appendix A). Additionally, the status of some populations has changed since the listing rule with six populations declining and one improving in status (USFWS, 2023). The current population size of extant Blodgett's silverbush populations in MiamiDade County is approximately 9,152 plants, which is close to the estimated population size at the time of listing (8,985 plants; Service 2016). Notably, 8 of the 11 extant populations consist of fewer than 100 plants and only 3 (Larry and Penny Thompson Memorial Park, Camp Owaissa Bauer Area, and Long Pine Key in Everglades National Park) have over 1,000 plants. The current population size of extant Blodgett's silverbush populations in Monroe County is approximately 11,885 plants, which is approximately 1,300 fewer plants than the estimated population size reported at the time of listing (13,200 plants; Service 2015 based on the Hodges and Bradley

2006 report). The difference is mostly attributed to the decline in the species at the two Naval Air Station Key West populations, between which over 1,400 plants were estimated to occur at the time of listing (Bradley and Hodges 2006; FNAI 2011, 2022; Service 2016), but only 106 plants were documented in early 2022 (Texas A & M University [TAMU] 2022). However, since the population on Big Munson Island is by far the largest with 8,000 to 9,000 plants according to Hodges and Bradley (2006) and there is no recent population estimate, the total number of plants in Monroe County could change considerably depending on the current size of the Big Munson Island population. Additionally, many of the populations in Monroe County may have experienced impacts from Hurricane Ian in October of 2022, which passed over the Keys with tropical storm force winds after the most recent surveys occurred for this review. Notably, as of April 2022, 12 of the 15 extant populations consist of fewer than 100 plants and only 3 (Lignumvitae Key Botanical State Park - Island, Cactus Hammock/Long Beach Area in National Key Deer Refuge, and Big Munson Island) have over 1,000 plants (USFWS, 2023)

***Threats and Stressors***

**Stressor:** Agricultural and residential development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pine rocklands in Miami-Dade and Monroe Counties have lost nearly 90 percent of their area due to agricultural and residential development (OBrien 1998, p. 208). Development has reduced the coverage of pine rocklands from 130,358 acres (52,754 ha) to 15,256 acres (6,174 ha) (OBrien 1998, p. 208). Most of the ecosystems on the Keys have been impacted by humans, through widespread clearing of rockland hammocks in the 19th century for farming, or building of homes and businesses (Hodges and Bradley 2006, p. 6). Habitat loss continues to occur in its range, and most remaining suitable habitat has been negatively altered by human activity. Outside of ENP, only about one percent of the Miami Rock Ridge pinelands have escaped clearing, and much of what is left is in small remnant blocks isolated from other natural areas (Herndon 1998, p. 1) (USFWS, 2016).

**Stressor:** Habitat Fragmentation/Fire suppression (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat fragmentation leads to the possibility of fire suppression in and around these isolated fragments. While this plant is not entirely limited to fire-maintained pine rocklands, fire suppression threatens the survival of Blodgett's silverbush. Pine rocklands need regular fires to prevent hardwood encroachment and excessive accumulations of litter. Under natural conditions, lightning fires typically occurred at 3- to 7-year intervals. With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like Blodgett's silverbush. Fire suppression has reduced the size of the areas that burn and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Thus, many pine rocklands are gradually becoming tropical hardwood hammocks. Fire suppression threatens the Blodgett's silverbush at more than half of its remaining sites (Bradley and Gann 1999, p. 6; K. Bradley, pers. comm. 2007). The staff at NKDR is beginning to monitor the response of rare plants, including Blodgetts silverbush, to prescribed fire after years of fire suppression on the Refuge (Anderson 2010, slide 20). They have noted an increase in Blodgett's silverbush post fire.

Approximately 20 plants were recorded in the monitored area prior to the burn, and 342 plants were detected 4 months post-fire (Anderson 2010, slide 20) (USFWS, 2016).

**Stressor:** Nonnative plants (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative (exotic) plant taxa have significantly affected pine rocklands. As a result of human activities, at least 277 taxa of exotic plants are now known to have invaded pine rocklands throughout south Florida (Service 1999, p. 3-175). A few of these exotic plants include the Schinus terebinthifolius (Brazilian pepper), Neyraudia reynaudiana (Burma reed) and Melaleuca quinquenervia (melaleuca). Lygodium microphyllum (Old World climbing fern) is rapidly spreading and may become a serious problem (Volin et al. 2004, p. 445). Nearly all of the extant occurrences are threatened by exotic plant species (Bradley and Gann 1999, p. 6; Hodges and Bradley 2006, p. 43; K. Bradley, pers. comm. 2007). Exotic species have altered the type of fire that occurs in pine rocklands. Historically, pine rocklands had an open, low understory where natural fires remained patchy with low temperature intensity, thus sparing many native plants such as Blodgett's silverbush. The current density of exotic plant overgrowth throughout the range of Blodgett's silverbush may no longer allow the species to be conserved through fire. Dense growth can create intense fire temperatures and longer burning periods. Pine rockland plants cannot tolerate these extreme conditions. Given the current conditions, exotic plant control may require an alternate method, such as hand chopping followed by spot herbicide treatment, which requires extensive labor and is very costly. This method may not be feasible for publicly owned lands, because of the acreage and staffing and budget constraints (USFWS, 2016).

**Stressor:** Road maintenance (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Several occurrences exist near roads and road maintenance is a particular concern to each of these occurrences (Bradley and Gann 1999, p. 6; Hodges and Bradley 2006, pp. 11-15; K. Bradley, pers. comm. 2007). Clearing of vegetation along roads and the use of herbicides could impact populations; coordination needs to exist with road maintenance crews to prevent impacts (Hodges and Bradley 2006, pp. 11-15). Road enhancements (e.g., paving) or other infrastructure projects (e.g., underground cable, sewer and water lines) may also threaten some roadside populations (Hodges and Bradley 2006, pp. 11, 15). Illegal dumping is identified as a problem at two sites (Hodges and Bradley 2006, pp. 11, 13). Since Blodgetts silverbush (and 10 other rare species) are included in an Important Rare Plant Area (IRPA) on Big Pine Key, management along this FDOT right-of-way could improve (Gordon et al. 2007, pp. 2, 68) (USFWS, 2016).

**Stressor:** Natural disturbances (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Given the species narrow range and the small number of individuals at many sites, Blodgett's silverbush is vulnerable to natural disturbances, such as hurricanes. Storm surges associated with hurricanes result in inundation of habitat with saltwater for varying durations. In 2005, the Keys were impacted by three hurricanes (Katrina, Rita, and Wilma), and vegetation in

many areas was top-killed due to salt water inundation (Hodges and Bradley 2006, p. 9). Storm surges may pose a threat to the population at Cactus Hammock on National Key Deer Refuge; however, hurricanes may also ultimately help this species by creating canopy gaps where this species thrives (Hodges and Bradley 2006, p. 12). According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean so this threat is expected to continue (USFWS, 2016).

**Stressor:** Inbreeding depression (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species occurs in a restricted range, and many occurrences are small and isolated. As a result, threats associated with small population size ensue. These include potential vulnerabilities from environmental (catastrophic hurricanes), demographic (potential episodes of poor reproduction), and genetic (potential inbreeding depression) threats (USFWS, 2016).

**Stressor:** Pesticide effects on pollinators (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Critical habitat regulations for Bartram’s scrubhairstreak butterfly and Florida leafwing have extended benefits to populations of these four plants and their pollinator guild by limiting mosquito insecticide activity in pine rocklands habitat in the Florida Keys. Nevertheless, we are proceeding cautiously and have initiated a multi-year research project to further investigate the level of impact pesticides have on these four plants and their pollinators throughout their ranges (USFWS, 2016).

**Stressor:** Fire suppression (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire suppression is a primary cause of habitat degradation in pine rockland preserves and is likely to suppress Blodgett’s silverbush seed germination (Possley et al. 2019). Fragmentation has also impacted the management of pine rockland habitat, as urbanization has encroached into native areas, leaving small habitat fragments that are increasingly difficult to burn. Habitat management with use of controlled burns remains a vital way to maintain pine rockland habitat. Without proper fire management, cover of hardwoods increase, along with invasion by non-native exotic plants, causing deterioration of ideal habitat for Blodgett’s silverbush. Hardwoods and non-native invasive plants directly compete with Blodgett’s silverbush for space, light, water, and nutrients. Although the species can tolerate some human disturbance and sometimes even seems to benefit from it if these disturbances create canopy openings (e.g., trails in within preserves or mowing along roadsides), five populations and four subpopulations are now extirpated due to development or significant disturbance of its habitat. Other populations growing on private property remain at high risk of extirpation due to development or disturbance and roadside populations in Monroe County are vulnerable to impacts from road maintenance projects such as herbicide application, grading, and resurfacing (USFWS, 2023).

**Stressor:** Climate Change (USFWS, 2023)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate Change. Climate change presents a variety of threats to Blodgett's silverbush and its habitat. Florida's average annual temperature has risen more than 2˚F since 1900 and estimates project further increases between 2.3-11.4˚F by 2100, depending on the greenhouse gas emission rates and the region in Florida (Runkle et al. 2022). In addition, it is predicted that south Florida will experience drier summers (Sun et al. 2015; Runkle et al. 2022). Higher temperatures and changes in precipitation patterns could alter relative humidity levels and evapotranspiration rates, leading to the potential for more frequent and intense droughts and wildfire events. Although Blodgett's silverbush has evolved to grow in habitats that experience frequent fire, prolonged periods of record high temperatures associated with droughts contribute to dry conditions that are driving hotter, more intense wildfires than would naturally occur. Intense wildfires can cause drastic changes in species composition, changes in tree density, and potentially kill Blodgett's silverbush (Possley et al. 2022a). Sea Level Rise. Sea level rise, saltwater intrusion, and storm intensification are also anticipated impacts of climate change and increasing threats to south Florida and Blodgett's silverbush. By 2100, it is predicted that sea levels in south Florida and the Keys will rise between 2.13 ft (0.64 m) and 7.12 ft (2.17 m) (Sweet et al. 2022). Based on this, areas supporting Blodgett's silverbush (e.g., coastal Miami, Florida Keys) will likely become partially or completely inundated by 2100. For example, approximately 75 percent of land mass in the Florida Keys is predicted to be inundated at 1.9 ft (0.59 m) of sea level rise (The Nature Conservancy 2011) and 94 percent of the Keys would be inundated at 5.9 ft (1.8 m) of sea level rise (Zhang et al. 2011). Sea level rise and saltwater intrusion have been found to reduce pine rockland acreage in the lower Keys (Ross et al. 1994) and will have impacts on other habitats as well. Prior to surface inundation, Blodgett's silverbush habitats may undergo vegetation shifts triggered by changes to hydrology, increased salinity, and more frequent storm surge and king tide events (S. Saha et al. 2011). Even if high tide or surge flooding is infrequent, most pine rocklands, rockland hammocks, and coastal berms in the Florida Keys will still slowly degrade and shift to buttonwood/mangrove or marsh habitats (Ross et al. 2009; A. Saha et al. 2011), making some sites unsuitable for Blodgett's silverbush. Hurricanes and Extreme Weather Events. Hurricane rainfall and intensity are expected to increase as the climate warms (Runkle et al. 2022). Given the small, isolated populations and restricted range of Blodgett's silverbush in locations prone to storm influences, nearly all known populations are at substantial risk from hurricanes and storm surges. Although this species naturally occurs in an area historically affected by hurricanes and has evolved to persist under such disturbances, an increase in storm intensity and its impacts could negatively affect populations. Hurricane winds and debris can cause mortality by defoliation, mechanical injury, or uprooting of individuals, leading to irreversible desiccation. Storm surge physically washes away plants and substrate and leads to salinization of soils. These pulses of salinization will exacerbate saltwater intrusion and accelerate habitat modification and loss. Blodgett's silverbush may have experienced these disturbances historically but had the benefit of more abundant and contiguous habitat to buffer populations from extirpation. With much of the historical habitat having been destroyed or modified, smaller populations are particularly vulnerable to local extirpations due to these events. The impacts of Hurricane Ian, which passed over the Keys with tropical storm force winds in October of 2022, have not yet been assessed and may have negatively impacted Blodgett's silverbush populations, especially in the Lower Keys (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Not relevant.

Recovery Priority Number: 8

**Delisting Criteria:**
Not defined; a Recovery Plan has not been issued as of December 2019.

**Recovery Actions:**

- Not defined; a Recovery Plan has not been issued as of December 2019.
- Prevent further destruction or degradation of existing pine rocklands and hammocks (Service 1999, p. 3-191).
- Acquire available fragments, promote conservation easements and landowner agreements, work with private landowners, and enforce regulatory protection of pine rocklands (Service 1999, p. 3-191).
- Prevent further degradation of existing preserves from exotic plant species, fire exclusion, anthropogenic fires, unauthorized site uses, illegal dumping, improper siting of facilities (including interpretive trails), collecting of plants, hydrologic modifications including drainage, flooding and salt-water intrusion, and herbicides by working with Federal, State, county, and municipal agencies and non-governmental organizations (Service 1999, p. 3-192).
- Restore existing degraded pine rocklands through active management (e.g., where possible restore natural connections, natural fire regimes, and areas impacted by anthropogenic fires, unauthorized site uses, illegal dumping) (Service 1999, p. 3-192).
- Monitor populations on a regular basis to track trends within the population and changes in management needs (Hodges and Bradley 2006, p. 19).
- Design and implement a coordinated system of informing maintenance crews about populations of Blodgett's silverbush occurring along roads and rights-of-way (Hodges and Bradley 2006, p. 19). Raise awareness among maintenance workers and contractors.
- Evaluate the use of herbicide application along roadside populations.
- Conduct studies involving reproductive biology or life history (Hodges and Bradley 2005, p. 19). Ephemeral populations of this species present challenges; little is known about long-term continuity of population sizes (Hodges and Bradley 2005, p. 19). Reproductive biology studies would provide information on effects of unnatural disturbance and mosquito spraying on pollinators (Hodges and Bradley 2006, p. 19).
- Use prescribed fire and incorporate monitoring into plans to determine the effectiveness of the prescription; monitor the health of the community and species that occur with Blodgett's silverbush (Bradley and Gann 1999, p. 4).
- Consider a plan of action to establish a Florida Keys pine rockland core conservation area and ex-situ conservation of this species (Ross et al. 2009, p. 477)
- • For populations in pine rockland habitat (all populations in Miami-Dade County, except Fuchs Hammock Preserve, and the National Key Deer Refuge populations in Monroe County), ensure that prescribed fire is frequent enough to maintain the open, sunny habitat required by Blodgett’s silverbush and to promote seed germination. • For populations in hammock or other areas where fire is not feasible (Fuchs Hammock Preserve and most of the Monroe County populations), clear dense undergrowth regularly. • Continue invasive

species removal at conservation areas with Blodgett's silverbush. • Acquire or pursue conservation agreements for populations or subpopulations on nonconservation private lands that are extant (Ludlam Florida Power and Light Easement and Marathon International Airport) and uncertain (Camp Choee, Country Ridge Estates, Epmore Drive Pineland, Boot Key, Big Munson Island, and Stock Island Golf Course), if it is determined that Blodgett's silverbush is extant. • Bank seeds from wild populations, with a focus on those that are not yet represented or are under-represented in storage (see section II.C.1.g., above for which populations are represented). Efforts should be especially concentrated on collecting seeds from populations of the Florida Keys, which are currently not represented in any seed banks. • Consider augmenting known extant natural and introduced populations or subpopulations with fewer than 10 individuals (George N. Avery Pineland, Pine Ridge Sanctuary, John Kunkel Small Pineland, Tavernier Roadside, Green Turtle Hammock, Key Tree Cactus Preserve, National Key Deer Refuge – Watson Hammock Area, and Key West Tropical Forest and Botanical Garden) (USFWS, 2023).

***Conservation Measures and Best Management Practices:***

- Monitoring/Research Activities • Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, rockland hammock, coastal berm, and disturbed areas. • Conduct range-wide surveys at uncertain and extirpated populations and adjacent parcels with potential habitat to determine the status of populations and/or to fine-tune population size estimates. Repeat every 5-10 years. • Survey Blodgett's silverbush populations after storms since population sizes could change substantially due to more open habitat. • Re-test seeds that Fairchild has banked at 5 years, to determine how long viability is retained in storage and repeat tests every 5 years thereafter. • Conduct germination experiments with seeds collected in the Florida Keys to determine if germination requirements are different to mainland populations and populations in the Florida Keys. • Further research on the reproductive biology and life history of Blodgett's silverbush (e.g., pollinators). • Conduct genetic research to determine the amount of genetic variation between populations from the mainland and the Florida Keys, and between Florida populations and those of Argythamnia argothamnoides populations across the Caribbean and northern South America (USFWS, 2023).

**References**

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Proposed Rule. 80 FR 58536-58567 (September 29, 2015).

USFWS. 2016. Endangered Species Status for Chamaecrista lineata var. keyensis (Big Pine Partridge Pea), Chamaesyce deltoidea ssp. serpyllum (Wedge Spurge), and Linum arenicola (Sand Flax), and Threatened Species Status for Argythamnia blodgettii (Blodgett's Silverbush)

Final Rule. 81 FR 66842 - 66865 (September 29, 2016).

Final Rule. 81 FR 66842 - 66865 (September 29, 2016). USFWS. 2023. Blodgett's Silverbush (Argythamnia blodgettii). 5-Year Review: Summary and Evaluation. Southeast Region. Florida

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USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Argythamnia blodgettii (Blodgett's silverbush). U.S. Fish and Wildlife Service, 03/26/2013, Region 4, Southeast Region. 17. p.

# SPECIES ACCOUNT: *Asclepias meadii* (Mead's milkweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 9/1/1988; Midwest Region (R3) (USFWS, 2016)

**Physical Description**

A perennial herb with a single slender unbranched stalk, 8-16 inches (20-40 centimeters) high without hairs but with a whitish waxy covering. The hairless leaves are opposite, broadly ovate, 2-3 inches (5-7.5 centimeters) long, 3/8-2 inches (1-5 centimeters) wide, with a whitish waxy covering. A solitary umbel at the top of the stalk has 6-15 greenish ivory/cream colored flowers. Young green fruit pods appear by late June and darken as they mature, reaching 1.5-4 inches (4-8 centimeters) by late August or early September. Seeds are mature by mid-October (USFWS, 2003).

**Taxonomy**

Mead (1846) originally identified the plant as Asclepias cordata, but it was later described as a separate species by Torrey as Asclepias meadii (Gray 1856) (USFWS, 2003).

**Historical Range**

Indiana, Kansas, Missouri, Iowa, Illinois, and Wisconsin (USFWS, 2012)

**Current Range**

Extant populations are present in eastern Kansas, Missouri, south-central Iowa, and southern Illinois. Populations have been introduced into Indiana and Wisconsin; natural populations are considered extirpated (USFWS, 2012).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, Asexual (USFWS, 2003)

**Lifespan**

Adult: 15 years or more (USFWS, 2003)

**Dependency on Other Individuals or Species**

Adult: Bumblebees and miner bees for pollination (USFWS, 2003)

**Breeding Season**

Adult: Flowers in late May and early June; fruits from June to October (USFWS, 2003)

**Reproduction Narrative**

Adult: Flowers in late May and early June; fruits from June to October. This species has low reproductive rate; research suggests that Mead's milkweed will require 15 years or more to mature from a germinating seed to a flowering plant. Species is long-lived and may persist indefinitely or until destroyed by chance impacts from animals or pathogens (USFWS, 2003). Reproduction is apparently rare. In an 11 year study, Kettle et al. (2000) found that only 15% of flowering stems produced mature fruit (NatureServe, 2015).

**Habitat Type**

Adult: Terrestrial (USFWS, 2003)

**Habitat Vegetation or Surface Water Classification**

Adult: Tallgrass prairie, hay meadows, thin soil glades or barrens (USFWS, 2003)

**Geographic or Habitat Restraints or Barriers**

Adult: Mead's milkweed usually occurs between 800-1200 feet above sea level on middle and upper portions of slopes less than 20 percent (Freeman 1988) (USFWS, 2003).

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Mead's milkweed usually occurs between 800-1200 feet above sea level on middle and upper portions of slopes less than 20 percent (Freeman 1988). Such habitats are often described as drymesic and represent a wide range of landtypes and substrates. The southern part of this species' range is unglaciated, and soils are developed in loess or residual material from underlying sandstone, chert, dolomite, shale, and igneous bedrock. These soils are acidic and nutrient poor in comparison to the soils found in northern populations. In the northern part of its range, soils are developed in glacial drift often with a deep mantle of loess. A single population found in the driftless area of Wisconsin probably occurred in loess over dolomite. These soils are calcareous and high in nutrients and organic matter. Soils in Kansas habitats have intermediate pH levels, nutrients, and organic matter. In general, Missouri and southern Illinois sites are acid and nutrient poor, Kansas sites are intermediate, and Iowa and northern Illinois sites are calcareous and nutrient-rich (Table 2) (USFWS, 2003). Restricted to sites that have never been plowed and only lightly grazed, and hay meadows that are cropped annually for hay (USFWS, 2003).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Abiotic, Bird, Mammal (EPA, 2016)

**Dispersal/Migration Narrative**

Adult: Seeds are wind dispersed from follicles (USFWS, 2003)

***Population Information and Trends***

**Population Trends:**

Decline of 70-80% (NatureServe, 2015)

**Species Trends:**

Decline of 10-30% (NatureServe, 2015)

**Number of Populations:**

346 (USFWS, 2021)

**Population Size:**

Uncertain (NatureServe, 2015)

**Population Narrative:**

As of February, 2015, there are approximately 212 occurrences observed since 1994: 177 in Kansas, 30 in Missouri, 3 in Iowa, and 2 in Illinois. The clone-forming nature of the species makes it difficult to determine number of individuals at each site. In addition, non-flowering stems are difficult to detect in tall grass (Alexander et al. 1997). There are 22 occurrences with good viability/integrity (NatureServe, 2015).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mead’s milkweed habitat is threatened by urbanization, conversion to agricultural land, and habitat fragmentation. Many Mead’s milkweed populations are also experiencing habitat loss due to the lack of appropriate prairie management such as prescribed fire. Fire suppression provides opportunities for subsequent woody vegetation encroachment, and invasion by exotic cool season grasses. Habitat destruction from feral hogs has also reduced Mead’s milkweed habitat (USFWS, 2012).

**Stressor:** Disease or predation (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Weevil damage to stems and developing fruits can affect seed viability. Other milkweed species may act as reservoirs for weevil populations, which then migrate to the rarer Mead’s milkweed. Herbivory of Mead’s milkweed from white-tailed deer has been observed at many sites across the species range and contributes to a lack of fruit production. Grazing by cattle and to a lesser degree by bison can adversely affect Mead’s milkweed populations, especially when grazing occurs during flowering and fruiting periods from April to September. In Missouri, some Mead’s milkweed populations are also experiencing fungal attacks (USFWS, 2012).

**Stressor:** Hay mowing (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Over 50% of Mead's milkweed sites are usually mowed annually for hay. Haying during the growing season prevents seed production of Mead's milkweed and results in reduced genetic diversity. Although haying and grazing occur on a large scale and may be a much more serious threat to the species, off-road vehicle use, in some cases associated with oil wells on a site, and trampling by researchers and school groups also adversely affects Mead's milkweed through excessive disturbance to its habitat. A proposed pipeline replacement project and highway construction project could potentially affect several Mead's milkweed populations in Kansas, however project sponsors are discussing alternatives with the USFWS Kansas Field Office (USFWS, 2012).

**Stressor:** Herbicide application (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the Osage Plains physiographic region, reference to herbicide damaged Mead's milkweed plants was specifically made in occurrence records for three populations (Doering Place, Mount Hope Prairie, and Nodding Polytaenia Prairie). Constant herbicide application has been reported as a contributing factor in the decline of Mead's milkweed in railroad prairies (USFWS, 2012).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The protection of federally threatened plants on privately-owned lands is extremely limited in all states throughout the Mead's milkweed range, leaving those populations vulnerable to habitat destruction and eventual extirpation. Currently, only about 11% of Mead's milkweed sites have legal protection. Most Mead's milkweed populations occur on private land, most of these are hay meadows, and most are, therefore, not protected from habitat destruction, the primary threat to this species (USFWS, 2012).

**Stressor:** Other natural or manmade factors affecting its continued existence (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change will be a particular challenge for endangered, threatened and other at-risk-species because the interaction of additional stresses associated with climate change and current stressors may push them beyond their ability to survive. In addition, populations of some species that are near the southern end of the range may be at particular risk. There is uncertainty about the exact nature and severity of climate change related impacts that may be anticipated to occur within the Mead's milkweed's range. A number of scientific studies project that there will be increased duration and intensity of heat waves in summer, higher levels of humidity and evaporation, changing patterns of precipitation with fewer rain events of greater intensity, increased frequency and more severe dry spells, and more flooding from heavy rains. Research has suggested that climate change may also negatively impact pollinator species if plants and their pollinators respond differently to climate change. These climatic changes may threaten the Mead's milkweed in a variety of direct and indirect ways including: changes in the timing of blooming, loss of suitable habitat, loss of inter-specific relationships with pollinators, and

increased threats from invasive species (USFWS, 2012).

**Stressor:** Feral Swine (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Feral swine were originally introduced to the southeastern United States and California in the early 1500s, but their range has increased substantially over the last several decades across the United States. The distribution and abundance of feral swine varies with habitat type but is highly correlated with the presence of public lands. Feral swine damage natural resources by destroying native vegetation, causing soil erosion, degrading water quality, and acting as a vector for many diseases. Feral swine have contributed to substantial habitat destruction in Missouri including severe damage to Mead’s milkweed plants at some locations (Mark Twain National Forest 2009, USFWS 2012). Feral swine have been reported in all states of the Mead’s milkweed distribution; however, swine are believed to be eradicated from Wisconsin and Iowa, with near eradication achieved in Illinois and Indiana (USDA-APHIS 2020). Historically, feral swine have overlapped in the Mead’s milkweed distribution in 4 counties in Kansas (accounting for 138 Mead’s milkweed sites), 11 counties in Missouri (58 sites) and 1 county in Illinois (1 site; Figure 2). (USFWS, 2022)

**Stressor:** Climate Change (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Long-term changes in environmental conditions (e.g., patterns of temperature and precipitation) have had observable impacts on plants, wildlife, ecosystems, and the ecosystem services they provide to society (Groffman et al. 2014, USGCRP 2018). Mead’s milkweed may be directly impacted by the changes to water quality, drought and flooding, and the spread of invasive species. Such changes are projected to continue. Without substantial and sustained reductions in global greenhouse gas emissions, extinctions and transformative impacts on some ecosystems cannot be avoided in the long term. More frequent and intense extreme weather and climate�related events, as well as changes in average climate conditions, are expected to continue to damage infrastructure, ecosystems, and social systems that provide essential benefits to communities (USGCRP 2018). The frequency of flood events has increased across the southeastern region and across most of the Midwestern U.S. over the past two or more decades (Neri et al. 2019). Climate change projections predict warming average temperatures, more days with extreme heat, increased extreme precipitation events, and longer periods of drought (IPCC 2014, USGCRP 2018) (USFWS, 2022)

**Stressor:** Pollinator Declines (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mead’s milkweed are primarily pollinated by large bees, including the species European honeybee (Apis melifera), rusty patched bumblebee (Bombus affinis), brown-belted bumblebee (B. griseocollis), Southern Plains bumblebee (B. fraternus) and the chimney bee (Anthrophora abrupta), (Betz et al. 1994, Edens-Meier et al. 2017). Hallmann (2017) reported severe losses of flying insects across the globe, with several taxa of pollinators (e.g., butterflies,

wild bees, and moths) experiencing large declines. In most ecosystems, bees are the dominant pollinators; however, compounding stressors (e.g. habitat loss, food stress, exposure to pesticides, pathogens, and climate change-related impacts) have led to wide scale declines (Rhodes 2018). In North America, losses of bees in grasslands commenced in the early 19th century (Samson and Knopf 1994), while a largescale bee decline in the U.S. Midwest occurred as agriculture practices intensified between the 1940s and 1960s (Grixti et al. 2009). Mead's milkweed pollinators, particularly bumblebees, have declined throughout the United States. (USFWS, 2022)

***Recovery***

**Reclassification Criteria:**
Not available.

**Delisting Criteria:**
1. Twenty-one populations are distributed across plant communities and physiographic regions within the historic range of the species (USFWS, 2003).

2. Each of these 21 populations is highly viable. A highly viable population is defined as follows: more than 50 mature plants; seed production is occurring and the population is increasing in size and maturity; the population is genetically diverse with more than 50 genotypes; the available habitat size is at least 125 acres (50 hectares); the habitat is in a late-successional stage; the site is protected through long-term conservation easements, legal dedication as nature preserves, or other means; and the site is managed by fire in order to maintain a late-successional graminoid-vegetation structure free of woody vegetation (USFWS, 2003).

3. Monitoring data indicates that these populations have had a stable or increasing trend for 15 years (USFWS, 2003).

**Recovery Actions:**
- Assess the viability of populations and protect habitat. Assess the viability of each population. Contact landowners and encourage conservation. Seek legal dedication. Increase number of sites managed or owned for the conservation of plant communities associated with Mead's milkweed in perpetuity (USFWS, 2003).
- Manage habitat. Conduct management assessment of public and private lands. Perform prescribed burns on a regular basis in Mead's milkweed habitat. Control invasive species in habitat with extant populations of Mead's milkweed (USFWS, 2003).
- Increase size and number of populations. Assess genetic condition of extant populations. Estimate the number of ramets and genotypes by collecting morphological data. Determine if genetic lineages occur among populations. Increase genetic diversity by introducing seeds or plants. Select sites for introduction and restoration. Select sites for augmentation based on variables in population viability index. Introduce or restore new populations in historic sites and newly identified habitat. Establish new populations using seeds or plants (USFWS, 2003).
- Conduct field surveys for new population occurrences or potential habitat for introduction
- Conduct research on restoration, management, and introduction techniques

- Maintain conservation populations. Collect and store seeds. Grow and maintain plants (USFWS, 2003).
- Promote public understanding. Produce a fact sheet and make it available on Service website. Hold workshops on managing Mead's milkweed sites. Create a traveling display. Promote news reports and press releases (USFWS, 2003).
- Review and track recovery progress. Reassess the viability of each population. Develop a post-delisting monitoring plan (USFWS, 2003).
- It is recommended that a plan be developed and implemented to collect information required to complete a thorough Population Viability Index for each population of Mead's milkweed. Data that is currently missing for most populations include population trend, number of genotypes, habitat size, and management condition. Regular population monitoring will be required in order to establish a population trend. A prioritization of sites based on the population's potential to become highly viable and contribute to recovery should be considered, however, this prioritization cannot be completed without the data that is currently missing from most populations. At the time a prioritization of sites is possible, this information should be provided to all recovery partners (state, federal, and non-government organizations) to provide guidance on where recovery should best be targeted. Protection through conservation easement, acquisition and dedication, or other protection should be sought for Mead's milkweed populations within each physiographic region that have high viability or that have the potential to become highly viable. Land acquisition funding sources should be explored including the U.S. Fish and Wildlife Service's Non-Traditional Section 6 Recovery Land Acquisition Grant Program (USFWS, 2012).
- The number of populations managed with prescribed burns and removal of invasive species should be increased. Over 50% of sites continue to be mowed for hay. This activity prevents seed production and results in reduced genetic diversity. Increasing the number of hay meadows that are managed to allow reproduction of Mead's milkweed through a reduction in haying and grazing, especially on public lands, would be beneficial to Mead's milkweed populations. The exploration of incentives offered by the U.S. Department of Agriculture, Natural Resource Conservation Service's (NRCS) Conservation Programs, whereby landowners are encouraged to manage their lands for the conservation of natural resources, may be beneficial in recovering Mead's milkweed. Some populations are also experiencing herbivory by deer or habitat destruction by feral hogs. Grazing, in general, adversely affects Mead's milkweed and patch/burn/graze management appears to be reducing the quality of Mead's milkweed habitat. In addition, information on habitat size and management condition may already be available but needs to be compiled. Management condition can also be assessed during population monitoring (USFWS, 2012).
- Although management efforts to improve habitat and remove threats have occurred in some populations, actual increase in population size has been rare. Seven high priority recovery populations have been targeted in Missouri for intense recovery efforts. Introductions are underway in Illinois, Indiana and Wisconsin and planned in Missouri. Augmentation occurred in Illinois, Missouri, and Kansas (Kindscher et al. 2008; Menard 2012), in order to increase genetic diversity and promote successful reproduction. These introductions are not always located in the physiographic regions or community types indicated in the recovery criteria. For this reason, surveys are needed to locate suitable locations for the introduction and establishment of new populations in the physiographic regions and community types listed in the recovery criteria. Because Mead's milkweed grows slowly and rarely reproduces, it may be decades before the already introduced

populations become viable (USFWS, 2012).

- There is a need for greater understanding of the species' life history requirements, specifically: phenology, pollination biology, and information on the species' reproduction in natural populations. Research indicates that introduction by transplanting juveniles reared in nurseries or greenhouses reduces time to reproduction and therefore should increase the potential viability of introductions (Bowles et al. 2003). Further research on restoration, management, introduction techniques, and the lack of reproduction in natural populations of Mead's milkweed will assist in the recovery of the Mead's milkweed. Establishing long-term seed collection of representative populations as well as establishing new, and maintaining current, propagation nurseries will also assist in the recovery of Mead's milkweed. Although a genetically diverse nursery population of Mead's milkweed is being maintained at the Morton Arboretum for introduction and augmentation purposes, a long-term seed collection protocol focused on representing populations throughout the range has not been established and would contribute to recovery of Mead's milkweed (USFWS, 2012).
- Statewide recovery groups have been developed in Missouri and Kansas. It is recommended that the states of Illinois, Iowa, and Wisconsin also develop recovery groups, which can be defined as either one recovery group for each state or one recovery group for all three states (WI, IA, and IL) that would include representatives from each state (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct surveys and monitoring. The PVI analysis conducted for Mead's milkweed was originally implemented as a preliminary calculation, and likely overestimates viability. It is important that more accurate analyses are conducted; however, to do so the current status of each population is needed with regular monitoring following. 2. Complete a Species Status Assessment. Since listing, many populations have not been monitored and their status remains unknown. Threats from feral swine, climate change, and a lack of appropriate management compound the risks to Mead's. Once sufficient data is gathered for a more accurate viability analysis, a species status assessment (SSA) may be helpful to determine if the species should remain the same or reclassified under the ESA. 3. Coordinate with partners on monitoring and management needs. Coordination among Federal, State, and private entities on monitoring and management needs to be enhanced and improved. As noted in Moore et al. (2011), an adaptive decision/management framework is recommended to assess various management actions, as well as augmentations to increase genetic diversity. The proliferation of virtual meeting platforms (e.g., Zoom, and Microsoft Teams) allows for collaboration at a distance, which can facilitate meetings and conservation planning. Federal, State, private conservation groups, species experts, geneticists, management experts, university researchers, expert ecologists, and invertebrate specialists (especially pollination experts) should be included in these discussions. 4. Prioritize populations for restoration efforts. After site surveys are updated, sites that are considered optimal habitat with low genetic diversity or ramet counts should be identified for future reintroductions. 5. Manage sites to improve fecundity in Mead's milkweed. Generally, high fruit set was found when populations had >50 ramets flowering at once. Therefore, populations with fewer than 50 flowering ramets should be augmented, though sites left fallow for several years and then burned may show a large increase in flowering ramets. Synchronous flowering among populations of Mead's milkweed may also improve fecundity. Coordinating the timing of controlled burns across multiple sites is one way to accomplish this (Wagenius et al. 2020). A study investigating the effects of fire return interval and seasonality on flowering is needed to test this hypothesis. 6. Conduct studies on the impacts of climate change. Climate change will likely alter future viability of many Mead's milkweed populations, and future viability analyses should adjust for changing environmental conditions. Studies like Molano-Flores et al. (2019) should be conducted throughout the range of the species. 7. Conduct pollination research studies to assess limitations. To test for pollen limitation, a pollen supplementation study is needed that compares fecundity in open and hand‐pollinated treatments across populations with varying numbers of flowering ramets. Additionally, studies are needed to test for pollinator limitation. 8. Conduct genetic analysis to facilitate augmentations. Promote widespread gene flow across the range of Mead's milkweed. Future augmentations should focus on adding seedlings sourced from multiple different maternal plants to maintain levels of genetic diversity in populations. Additional genetic analyses of small populations are needed to test mate limitation and the presence of the Allee effect in Mead's milkweed. 9. Encourage voluntary management. Because the protection status of many populations is either unknown or the sites are unprotected, conservation organizations should encourage voluntary management strategies with landowners. 10. Evaluate the impacts of imperiled insect management. In managing Mead's milkweed habitat, we should also evaluate various management prescriptions on other listed and candidate species that co-occur with Mead's, especially invertebrates such as Rattlesnake master borer moth (Papaipema eryngii) and Monarch butterflies (Danaus plexippus). (USFWS, 2022)

- CONSERVATION MEASURES: Iowa: Powell Prairie in Taylor County and Woodside Prairie in Adair County are sites where Mead's milkweed has been reliably located. After approximately 20 years without surveys, both sites were surveyed in 2020 with only 1 sterile plant observed at Woodside Prairie. While both sites are small, these highly diverse prairie remnants located on private property recently underwent active conservation management for Mead's milkweed. These sites were burned, and habitat improvements also included removal of red cedar (Juniperus virginiana) trees. Indiana: The Indiana Plant Conservation Alliance (INPCA) has recently identified rare plants for conservation prioritization, including Mead's milkweed. A Mead's milkweed conservation team has been formed, and conservation planning includes future monitoring, conducting a literature review, and identifying appropriate habitat for potential future reintroductions (V. Witting – Indiana Plant Conservation Alliance, pers. comm. 2022). Monitoring of reintroduced populations is ongoing and continues to be managed for prairie species including Mead's milkweed recovery (S. Namestnik – Indiana DNR, pers. comm. 2022). Kansas: The Grassland Heritage Foundation has purchased a 15-acre prairie in Anderson County with a small population of Mead's milkweed. In 2018, a conservation easement was placed on a privately-owned, 80-acre prairie in Anderson County with a large Mead's population (M. McNulty - USFWS, pers. comm. 2022). Managing agencies have initiated burns at the formerly hayed Lexington Lake Park site in Johnson County, Kansas (C. Edwards – Missouri Botanical Garden, pers. comm. 2022). Missouri: Missouri Department of Conservation (MDC) acquired Berrier (formerly known as South Fork upland and Winn's Prairie) in 2020 and has initiated burns on the site (C. Edwards – Missouri Botanical Garden, pers. comm. 2022). Together with Missouri Botanical Garden (MoBOT), MDC conducted an augmentation at Berrier in 2020 (C. Edwards – Missouri Botanical Garden, pers. comm. 2022). Plantings occurred in 2011 and 2012, and these sites were monitored annually 2015-2017 to estimate establishment success and persistence. They continue to be monitored during the flowering season immediately after a prescribed burn. Remnant populations that are regularly managed and easily accessible are also surveyed immediately following a prescribed burn. Prescribed burns are predominately occurring during the dormant season. Seed pods were collected in 2013, and used to establish a propagation plot in 2015 at Powell Gardens. As of 2022, there are approximately 50 individuals within the plot. A seed pod was produced in 2019 but succumbed to insect damage. There have been a few flowering individuals in recent years and the plot is expected to serve as a seed source for future propagation efforts. Following recent studies that have provided better understanding of genetic diversity, future propagation efforts are expected, along with follow up studies to investigate the lack of seed production that is observed at several locations. Management activities (e.g., haying and burning) likely affect the height of individual plants and the number of observable plants, possibly contributing to low rates of fecundity (USFWS 2012). Another potential cause of low fecundity is a resource limitation. Upcoming research funded by MDC and conducted by the Missouri Botanical Garden is expected to evaluate these possibilities. Wisconsin: Three populations have been surveyed in the last 10 years and continued monitoring of these locations is planned. Interest has been expressed in identifying optimal habitat for future reintroductions (R. Henderson, pers. comm. 2022). (USFWS, 2022)

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# SPECIES ACCOUNT: *Asclepias prostrata* (Prostrate milkweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered

**Physical Description**

Prostrate milkweed is an herbaceous, flowering, perennial species with cream, yellow, greenish, or pinkish flowers (see Figures 4a and 4b). The plant has a distinctive odor, similar to the tree tobacco (Nicotiana glauca) (Santore 2019a, unpaginated). This species is distinctive in its prostrate habit; the leaves and stems hug the ground and sprawl outward from a woody crown (Figure 2). No other Asclepias species within the range has a prostrate habit; however, shortcrown milkvine and mesquite plains milkvine occur within the range of prostrate milkweed and are similar in appearance (USFWS, 2020).

**Taxonomy**

The taxonomic status of prostrate milkweed, Asclepias prostrata W.H. Blackwell, is well accepted. The species was first described by Blackwell in 1964 from a type specimen collected in 1960 in Tamaulipas (Blackwell 1964, p. 178; University of Texas Herbarium, #TEX00372529). The Genus Asclepias was formerly classified within its own family, the Asclepiadaceae (milkweed family); more recent phylogenetic analyses revealed that the genus is nested within Apocynaceae, the dogbane family (Sennblad and Bemer 1996, entire) (Table 1). No other synonyms have been proposed for this species (Poole et al. 2007, p. 98). Prostrate milkweed is a member of the Podostemma clade (Fishbein et al. 2011, p. 1018; Worcester 2015, p. v), which includes six species of milkweeds sharing a common ancestor (Fishbein et al. 2011, p. 1018; Worcester 2015, p. v). Most species in this clade have distributions that straddle the U. S.-Mexico border, with ranges of some extending to Central America or the U. S. Midwest (Figure 2 below). This clade contains Emory's milkweed (A. emoryi), Zizotes milkweed (A. oenotheroides), Mojave milkweed (A. nyctaginifolia), hierba de la mula (A. standleyi; Woodson 1954, p. 160), sand milkweed (A. arenaria), and prostrate milkweed (Fishbein et al. 2011, p. 1015). Prostrate milkweed is also morphologically similar to the species of subgenus Podostemma (USFWS, 2020).

**Historical Range**

In the United States, prostrate milkweed has been recorded from 16 populations in Starr and Zapata counties (Table 3). In Mexico, there are at least 8 known populations for this species occurring in isolated pockets widely scattered in northern Tamaulipas and eastern Nuevo León, many over 100 miles from the Rio Grande and 220 miles southeast of the northernmost population in Zapata County (Figures 11 and 12; Strong and Williamson 2015, p. 35). It is possible that prostrate milkweed was historically more abundant in Texas and Mexico and may once have had a larger range. Specifically, it is likely that there were populations of prostrate milkweed between their current known occurrences in Texas and Mexico; however, by 1990, the species was considered rare in Tamaulipas, Mexico (USFWS, 2020).

**Current Range**

As of 2020, in Texas, prostrate milkweed is restricted to 16 assumed extant populations in Starr and Zapata counties with all known populations of prostrate milkweed within 9 miles of the Mexican border (Figure 13). It is likely that prostrate milkweed occurs in other locations on private lands in Starr and Zapata counties that have simply not been surveyed or reported (USFWS, 2020).

**Critical Habitat Designated**

Yes; 3/30/2023.

**Legal Description**

We, the U.S. Fish and Wildlife Service (Service), are listing the prostrate milkweed (Asclepias prostrata), a plant species from Texas, as an endangered species and designating critical habitat under the Endangered Species Act of 1973, as amended (Act). We are designating approximately 661.0 acres (267.5 hectares) in Starr and Zapata Counties, Texas, as critical habitat for the prostrate milkweed under the Act.

**Critical Habitat Designation**

Critical habitat units are depicted for Starr and Zapata Counties, Texas.

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the physical or biological features essential to the conservation of Asclepias prostrata consist of the following components: (i) Well-drained sandy soil overlying strata of sandstone or indurated caliche

(ii) High soil gypsum concentration

(iii) Open savannas and grasslands of the Tamaulipan shrubland ecological region

(iv) Vegetation composition that includes abundant, diverse pollen and nectar plants and healthy populations of native bee and wasp species

(v) Less than 20 percent cover of Pennisetum ciliare (buffelgrass)

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the following threats: nonnative, invasive grass; rootplowing and conversion of native vegetation to buffelgrass pasture; ROW construction and maintenance from energy development and road and utility construction; border security development and law enforcement activities; and small population sizes. Management activities that could ameliorate these threats include, but are not limited to: prescribed burning, grazing, and/or brush thinning; nonnative, invasive grass control; protection from activities that disturb the soil; and propagation and reintroduction of plants in restorable areas. There are a variety of ways to manage the land to address the threats facing prostrate milkweed. In summary, we find that the occupied areas we are designating as critical habitat contain the PBFs that are essential to the conservation of the species and that may require special management considerations or protection. Special management considerations or protection may be required of the Federal action agency to eliminate, or to reduce to negligible levels, the threats affecting the PBFs of each unit.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, Asexual (USFWS, 2020)

**Lifespan**

Adult: Unknown. Possibly 1-2 yrs (USFWS, 2020)

**Dependency on Other Individuals or Species**

Adult: Insect pollinators (USFWS, 2020)

**Breeding Season**

Adult: Flowers Mar-Oct, sporadic and dependent upon rainfall (USFWS, 2020)

**Key Resources Needed for Breeding**

Adult: Rainfall (USFWS, 2020)

**Other Reproductive Information**

Adult: Milkweeds have remarkably complex flowers with unusual morphology making pollination a multi-step process (Wyatt and Broyles 1994, pp. 424-426). Milkweeds produce waxy masses of pollen in sacs called pollinia. Pollen remains enclosed in the pollinium until inserted into the stigma of another flower by an insect or other pollinator (Holdrege 2010 p. 13). The stigmatic surfaces are also enclosed with just a narrow slit for an opening (Holdrege 2010 p. 15). This specialization means that relatively few pollinia are successfully inserted into a stigmatic chamber (Holdrege 2010 p. 15). However, the design of the milkweed flower is all about attracting pollinators with nectar and ensuring that the pollinators pick up and move pollinia to a different flower to complete pollination (Dellinger 2016, unpaginated). No formal studies have been conducted regarding pollinators of prostrate milkweed. While all Asclepias species have highly specialized flowers, many are effectively pollinated by generalist insect pollinators. South Texas has a high species richness for Hymenoptera, so various species of bees and wasps may be pollinators (Damude and Poole 1990 p. 24). Milkweed pollinia are usually large structures so insects that are relatively large may be better able to function as pollinators (Maclvor et al. 2017 p. 8459; Dellinger 2016, unpaginated). Any insect large enough to acquire and transport the pollinia can serve as an effective pollinator of milkweed (Ivey et al. 2003, p. 215). Some insects are not robust enough to remove their legs from the anther slits with the attached pollinia and are trapped to die there if they do not lose their appendage first (Dellinger 2016 p. unpaginated). However, among 12 species of milkweed studied, the rare or uncommon species, specifically A. hirtella (tall green milkweed), Mead's milkweed, A. lanuginosa (woolly milkweed), and A. viridiflora (small green milkweed), seemed to have very few insect visitors attracted to them, compared to the common species (common milkweed, whorled milkweed, and Asclepias incarnata (swamp milkweed)) (Betz et al. 1994, p. 58), indicating a possible link between rare plants and pollinator declines (USFWS, 2020).

**Reproduction Narrative**

Adult: The specific reproductive biology of prostrate milkweed is unknown but may be inferred from similar milkweed species. While many milkweeds are rhizomatous (Fishbein In prep) and form clones via ramets (stems) in adjoining areas, it is not universal and has not been reported for prostrate milkweed. Prostrate milkweed has highly specialized pollinia (pollen sacs) and complex flowers containing both male and female structures (Damude and Poole 1990 p. 23). Further, most milkweed species are self-incompatible and require outcrossing, meaning that in order to produce fruit and seeds, flowers must receive pollen from another unrelated plant (Luna and Dumroese 2013, p. 11; Weitemier 2016, p. 3). Prostrate milkweed plants produce 1 to several tubers that form 30 cm (12 in) or more underground (see Figures 6 and 7). These tubers allow individuals to persist through long droughts, and may provide a limited amount of clonal reproduction. However, the species does not primarily reproduce through asexual means, such as rhizomes (USFWS, 2020).

**Habitat Type**

Adult: prairies/grasslands, and areas converted to pasture land (USFWS, 2020)

**Spatial Arrangements of the Population**

Adult: Clumped (Inferred from USFWS, 2020)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2020)

**Habitat Narrative**

Adult: Prostrate milkweed plants usually occur in open spaces with full sun, and with little to no competition from surrounding plants (Poole and Janssen 1997, p. 117). They require occasional rain and pollinators. Prostrate milkweed occurs in a warm, semiarid climate in sparsely vegetated sites, including disturbed sites, road rights-of-way, openings in shrub-invaded grasslands, open areas of Tamaulipan thornscrub, prairies/grasslands, and areas converted to pasture land on level or gently sloping sites on upland terraces and floodplains of the Rio Grande (Singhurst et al. 2015, p. 25; Carr 2004, p 30; Damude and Poole 1990, p. 13; Strong and Williamson 2015, p. 36). Elevations range from near sea level to 200 meters (656 feet) above sea level (Fishbein In prep., unpaginated; Martinez Avalos 2019, pers. comm.). Commonly associated native shrub and grass species include blackbrush (Acacia rigidula), honey mesquite (Prosopis glandulosa), lotebush (Ziziphus obtusifolia), cenizo (Leucophyllum frutescens), Texas pricklypear (Opuntia engelmannii var. lindheimeri), lovegrass (Eragrostissp.), grama (Bouteloua sp.), and hooded windmillgrass (Chloris cucullata) (USFWS, 2020).

***Dispersal/Migration***

**Dispersal**

Adult: Likely dispersed by wind (USFWS, 2020)

***Population Information and Trends***

**Population Trends:**

Decreasing (inferred from USFWS, 2020; USFWS, 2023)

**Number of Populations:**

28 (16 in U.S.) (USFWS, 2023)

**Population Size:**

Largest population has more than 50 individuals. All other populations <50 (USFWS, 2023)

**Additional Population-level Information:**

Only one of the 28 currently known occurrences (16 in TX) has more than 50 individuals, and all are far below the estimated MVP level of 1,600. the documented EOs are located on highway ROWs, two national wildlife refuge tracts, or a few private ranches that granted access for surveys, and comprise a very small proportion of the potential habitat. Plant populations are delimited by the extent of gene flow through seed dispersal and pollination. The potential range of wind-dispersal of prostrate milkweed seeds is unknown, but may be large. Furthermore, the spider wasp pollinators include some of the largest wasps, which presumably have relatively large forage ranges; hence, effective outcrossing may occur among individuals that are relatively distant. The ample nectar reward that milkweed flowers provide justifies foraging over a relatively extensive range. Therefore, it is likely that the documented EOs are small fragments of much larger populations that are, or were, widely dispersed over intact rangelands. We have no information on the forage ranges of spider wasps, but the default EO separation distance of 1.0 km is an acceptable preliminary estimate (USFWS, 2023).

**Population Narrative:**

Populations and gene flow. We estimate that the minimum viable population size (MVP) of prostrate milkweed is about 1,600 mature individuals (USFWS 2020, pp. 36–38). The 16 EOs in Texas, as well as the four newly-reported occurrences, all had very small populations when last observed; the largest had only 62 individuals, and 9 had no observed plants (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Nonnative grass
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative grasses continue to spread, especially near roads and into areas with disturbed ground; Highway 83 continues to be heavily infested. Ranchlands are less infested, where grazing keeps nonnative grass somewhat in check. Refuges and lands with conservation easements may increase control efforts.

**Stressor:** Mowing and Herbicides:
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mowing and herbicide treatments can either be a threat or a benefit, depending upon the timing of the action. In this scenario, mowing and herbicide treatments are not scheduled around dormant periods and are therefore usually harmful. Exceptions are in the populations that co-occur with listed plant species.

**Stressor:** Development
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Road projects are planned in several populations; some county roads are graded at least once a year, often during flowering and fruiting periods. The increase in wind energy projects will require more frequent road maintenance by the counties.

**Stressor:** Border security
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A new road is planned on a refuge tract population and other populations could be damaged by drag strip operations.

**Stressor:** Climate change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes in rainfall events, drought severity, soil moisture, and evaporation will have no effect or minimal effects.

***Recovery***

***Conservation Measures and Best Management Practices:***

-

***Additional Threshold Information:***

-
-

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# SPECIES ACCOUNT: *Asimina tetramera* (Four-petal pawpaw)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/27/1986; Southeast Region (R4)

**Physical Description**

Asimina tetramera is a 1 to 3 m tall aromatic shrub that has one to several stems arising from a deep taproot. Leaves are oblong to oblanceolate, 5 to 10 cm long, arranged alternately on the stem, and are yellow-green to deep green. The leaves are narrow at the base (A. Cox, Florida International University, personal communication 1995), have broadly acute or blunt tips, and lack stipules. The flowers are maroon and fetid. They occur singly in the leaf axil; however, if the plant is burned or damaged, two or three flowers may develop. Perianth parts are typically in whorls of three, but may vary. The petals usually form whorls. The stamens are spirally arranged on an elevated torus or ballshaped receptacle, surrounding one to many separate carpels. After fertilization, the receptacle expands as fruit develops. The fruit is an aggregate of developing carpels, or monocarps, on the expanding receptacle. The monocarps are indehiscent and berry-like. An individual flower may produce from one to eight monocarps with one to nine seeds each (A. Cox, Florida International University, personal communication 1995). The fruit are oblong and greenish-yellow, emitting a banana-like aroma when ripe (A. Cox, Florida International University, personal communication 1995). The laterally flattened seeds are dark brown and shiny (Austin and Tatje 1979, Kral 1983). (USFWS, 1999)

**Taxonomy**

The four-petal pawpaw was discovered at Rio, Florida, in 1924 and subsequently named ityothamnus tetramerus (Small 1926, 1933). However, the new genus was rejected by other taxonomists (Kral 1960). According to Kral (1960), Asimina tetramera is grouped with A. pygmaea, A. longifolia, and A. nashii. These species have several common characteristics, including flower development on new growth, sparsely and omentulose young shoots, and glabrous petioles, peduncles and leaf surfaces. Kral (1960) concluded A. tetramera more closely related to A. pygmaea than to the other Asimina species based on floral similarities. Both species have strongly recurved inner petals, are maroon, have a pungent aroma and flower between April and July. However, several differences separate these two species: the gynoecium of A. tetramera is larger than A. pygmaea, adult plants of A. tetramera are larger than adult plants of A. pygmaea, and A. tetramera is limited to sand pine scrub ridges in Martin and Palm Beach counties, while A. pygmaea occurs in mesic slash pine or long leaf pine habitats and savannas. (USFWS, 1999)

**Historical Range**

Historically, A. tetramera occurred in sand pine scrub habitat on the coastal dune system in Martin and northern Palm Beach counties, Florida (USFWS, 1999)

**Current Range**

15 sites in Martin and northern Palm Beach Counties, Florida, along a 30-mile stretch of sand pine scrub. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 1999)

**Breeding Season**

Adult: Flowering peaks in April and May, and continues throughout the summer. (USFWS, 1999)

**Other Reproductive Information**

Adult: Beetles are the most likely pollinators, although Dipterans (flies), Hymenopterans (wasps), and other insects have been observed visiting flowers. Gopher tortoises (Gopherus polyphemus), and small mammals such as the Florida mouse (Podomys floridanus) (Jones 1989) eat the fleshy fruit and may disperse seeds. Ingestion by animals is not necessary for seed germination. Asimina tetramera seeds germinate from September to March. Old, stored, or dried seeds will not germinate. Germination may take from 1 to 8 months after the seed is planted. The root system establishes several months before shoot emergence, and two to seven leaves are produced the first year. Asimina tetramera plants are deciduous, or partly so, with new leaves emerging in April and continuing to develop into summer. Buds are borne in the axils of the leaves as shoots develop. Flowers occur on new growth, and flower maturation proceeds from the base of the shoot toward the tip. Damaged stems sprout, producing new growth and may flower as late as September. Flowering peaks in April and May, and continues throughout the summer, with fruit ripening in 2 to 3 months. (USFWS, 1999)

**Reproduction Narrative**

Adult: Reproduction in A. tetramera is sexual. The perfect flowers open before all the parts are fully developed, and mature from the base of the stem toward the developing tip. They are protogynous, meaning that the stigmatic surface becomes receptive before anther maturation and pollen release. The petals fall from the flowers within one day of pollen release, and carpel development and receptacle enlargement follow successful pollination and fertilization. Flowers that are not pollinated fall soon after pollen release. (USFWS, 1999)

**Habitat Type**

Adult: sand pine scrub vegetation (USFWS, 1999)

**Habitat Vegetation or Surface Water Classification**

Adult: Terrestrial

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Asimina tetramera is found only in sand pine scrub vegetation on old, coastal dunes (Austin and Tatje 1979). The species grows in excessively-drained, quartz sand of both the Paola and the St. Lucie soil series (Austin et al. 1980; A. Cox, Florida International University, personal communication 1995); however, it shows a preference for the Paola soils (Farnsworth, 1988).

Asimina tetramera is found in various seral stages of sand pine scrub, ranging from open [no canopy] to mature [closed canopy] (A. Cox, Florida International University, personal communication 1997). A. tetramera is adapted to infrequent, intense fires, perhaps every 20 to 80 years (FWS 1988). Abundant flowering and fruitset occur in years following fire and diminish with maturation of the community and subsequent canopy closure (A. Cox, Florida International University, personal communication 1996b). (USFWS, 1999)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Gopher tortoises, and small mammals such as the Florida mouse (Podomys floridanus) (Jones 1989) eat the fleshy fruit and may disperse seeds.

***Population Information and Trends***

**Population Trends:**

Approximately half of the extant populations appear to be stable or increasing, while the rest are decreasing, or their status is unknown. (USFWS, 2022)

**Number of Populations:**

15 (USFWS, 2019)

**Population Narrative:**

The four-petal pawpaw can be found in sand pine scrub habitat in the coastal dune system of limited areas of Martin and Palm Beach Counties in southeast Florida (Kral 1960; Austin and Tatje 1979; Service 1999). The remaining four-petal pawpaw populations are declining due to further loss of habitat and may be characterized as existing on fragmented parcels within the historical range. While the four-petal pawpaw was historically documented in sand pine scrub areas of the south-central Atlantic Coastal Ridge of coastal Martin and northern Palm Beach counties, much habitat for the species has been destroyed or converted (Kral 1960; Service 1999; Florida Natural Areas Inventory (FNAI) 2000), and it is now found in a much smaller area from north of Palm Beach Gardens to the Savannas Preserve State Park in Martin County (Cox pers. comm. 1996a; Service 1999; Gann et al. 2002). The remaining populations of four-petal pawpaw occur within a narrow region of sand pine scrub habitat fragments that in 2018 included 15 sites — 11 public and 4 private sites (Service 1999; Gann et al. 2002; Cox pers. comm. 2018). Current information in 2018 shows four (4) of the 15 existing sites (27 percent) exist on private lands: three (3) in Martin County and one (1) in Palm Beach County (Cox pers. comm. 2018). Four-petal pawpaw occurred on approximately 26-27 historically known sites (Peterson 2008; Service 2009). (USFWS, 2019). Four-petal pawpaw is a long-lived shrub that occurs in coastal sand pine scrub within a limited range in Martin and Palm Beach counties, Florida. Remaining occurrences are fragmented and isolated within this range, and the species is estimated to occur in only 9 populations made up of 14 natural and augmented sub-populations with approximately 1,400 plants (Table 1). The previous status review (Service 2009) reported 16 populations made up of 21 sub-populations with approximately 1,800 plants. The status of some populations has been well documented while others remain in question due to accessibility issues. Approximately half of the extant populations appear to be stable or increasing, while the rest are decreasing, or their status is unknown. (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Continued habitat loss, fragmentation, and changes in land use threaten the existence of four-petal pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. Even though 68 percent of the sites containing four-petal pawpaw are publicly owned and not at risk of being developed, the plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Degradation to habitat can also occur from damage by feral hogs . Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in sand pine scrub habitat and the encroachment of exotic plants will continue to threaten four-petal pawpaw. (USFWS, 2009)

**Stressor:** Inadequacy of existing regulatory mechanisms
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The ESA provides limited protection for the species and its habitat. Existing federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The four-petal pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. Existing regulatory mechanisms do not appear to be adequate, as several properties with pawpaws on private lands have been developed. Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. (USFWS, 2009)

**Stressor:** Inadequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs in scrub habitat, which is typically maintained by fire. On many privately owned sites, fire has historically been suppressed and habitat has not received regular maintenance. Because fragmented habitat is interspersed on a developed landscape, burning may also be unlikely due to proximity to neighbors (Peterson 2008). If sites are not regularly maintained through fire or mechanical treatment, the overall health of the scrub system may be compromised and flowering and fruit set of fourpetal pawpaws may be reduced. (USFWS, 2009)

**Stressor:** Invasive nonnative plants
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Another major threat to pawpaws is the establishment of exotic plant species such as Brazilian pepper, rosary pea (Abrus precatorius), guinea grass (Panicum maximum), and natal grass (Rhynchelytrum repens) in the absence of maintenance, especially where native soil is disturbed. However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the four-petal pawpaw. Broad application of herbicide to remove Brazilian pepper and tall grasses can be especially damaging (Cox in litt. 2009). It is thought that plants on at least two sites have been affected by herbicide treatments (Cox 2006). (USFWS, 2009)

**Stressor:** Limited distribution and specialized habitat
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. Although the species faired well through the 2004 and 2005 hurricanes, specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction. Unfortunately, long-term seed storage does not seem to be a viable option for this species, as the seed does not persist (Peterson et al. 2008). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When sites within the historic range of A. tetramera are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the coastal sand pine scrub communities to support A. tetramera (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Priority Number: 11

**Delisting Criteria:**
1. At least 25 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)

2. Populations (as defined in criterion 1) occur in coastal sand pine scrub and are distributed across the historical range of the species. (Factor A, E) (USFWS, 2019)

3. Populations (as defined in criterion 1) must be protected via a conservation mechanism and/or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factor A, D, E) (USFWS, 2019)

**Recovery Actions:**

- Determine current distribution of A. tetramera. Some portions of A. tetramera's range have been well surveyed yet a total distribution has not been ascertained for this  pecies. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Atlantic Coastal Ridge has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Continue research on life history characteristics of A. tetramera. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of A. tetramera. Develop monitoring protocol to assess population trends for A. tetramera. Develop a quantitative description of the population structure of A. tetramera. Monitor introduced plants. (USFWS, 1999)
- Provide public information about A. tetramera. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of A. tetramera and other rare species requires self-sustaining, secure, natural populations in existing native scrub habitat. S6. Establish delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about xeric vegetative communities and their unique biota. (USFWS, 1999)
- Surveys: - Continue to survey potential habitat and pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage scrub for ecosystem health and listed species.  - Conduct additional surveys for four-petal pawpaw on all known and potentially suitable sites in the two counties of occurrence and provide updated information to FNAI for consistent tracking. - Continue monitoring for plants on both reintroduced and natural sites. - Monitor sites of special interest, such as those with altered water tables or in ecotonal areas at lower elevations. (USFWS, 2009)
- Management:  - Continue management actions to include removal of debris and exotics through careful herbicide application, controlling public access, and the reintroduction of prescribed fire into the ecosystem. - Portions of sites with four-petal pawpaw and dense sand pines should be burned on a regular basis to prevent accumulation of large fuel loads. - Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species. - Identify additional reintroduction sites and establish reintroduced populations;

population augmentations should also be implemented. (USFWS, 2009)

- Research: - Conduct research on the response of four-petal pawpaw to fire and fire prescriptions necessary to benefit the species. - Conduct additional research on the biology, ecology, genetics, and management needs of the species. - Continue demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages. - Compare the viability of the small sites in the northern portion of the range to the much larger southern site. - Conduct additional life history studies to enhance our understanding of observed genetic variance. - Continue to evaluate insect pollinators associated with the species over a longer term, and evaluate impacts to pollinators from aerial mosquito spraying, especially in the small, isolated sites in the northern portion of the species' range. - Continue seed germination studies and make efforts to develop additional outplanting techniques. - Continue genetic characterizations on sites that have not yet been studied, and apply this knowledge to future introductions and population augmentations. - Continue to collect germ plasm from the remaining sites not currently represented in the Center for Plant Conservation's National Collection of Endangered Plants. - Continue propagation efforts. - Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2009)
- Other: - Partnerships should be promoted to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. - Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize five- and ten-year goals. - Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities: • Collect germplasm from the remaining sites not currently represented in the Center for Plant Conservation's National Collection of Endangered Plants for ex situ safeguarding. • As informed by research on best methods and site characteristics (see Research/Monitoring below), continue seed collection, propagation, and direct planting for both augmentations and introductions. • Identify the most suitable introduction sites and carefully monitor any plants translocated or seeds planted. Use irrigation to help increase plant survival the first year. • If suitable habitat remains on publicly owned sites with extirpated populations, consider re-introducing four-petal pawpaw. Where habitat has degraded in areas of historical populations, perform restoration to return to suitable scrub pine habitat. • Carefully apply herbicide to invasive plant species in pawpaw habitat as needed and avoid pawpaw plants by ensuring all applicators know exactly where it is safe to spray. • Conduct prescribed fires, preferably in the spring lightning season, within appropriate fire return intervals to prevent accumulation of large fuel loads and create more favorable conditions for pawpaw reproduction. • If habitat/landscape level burns are not feasible because of wildland-urban interface or other challenges, experiment with conducting micro-burns around pawpaw plants. • As informed by additional genetic analysis (see Research/Monitoring below), focus conservation efforts on marginal and small sites to preserve genetic diversity. • As landowners are willing, acquire private sites with remaining pawpaw populations to ensure their protection or alternatively, enact conservation easements. • As a last resort and where needed, perform rescues of plants on private sites to be developed and translocate to protected land with suitable habitat. Research/Monitoring: • Investigate methods and site characteristics that lead to long-term introduction success. • Continue to survey potential coastal sand pine scrub habitat for new occurrences and provide updated information to FNAI. • Continue demographic monitoring on sites where populations have been followed and begin demographic monitoring on those sites where populations only have been periodically observed. Data on population size, reproductive rates, age class structure, and habitat conditions should all be documented. • Closely monitor for recruitment and determine the conditions required for growth. • Obtain permission from private landowners with historical pawpaw occurrences to survey and determine the status of these populations. If present, foster partnerships/working relationships with these landowners to protect plants. • Complete genetic analysis of populations to determine the amount and spatial distribution of diversity remaining to help inform further conservation actions, such as appropriate translocation material and locations. • Collect and analyze RAPD data on leaf samples from unsampled populations and create an updated dendrogram. • Continue to evaluate insect pollinators associated with the species and determine the status of these insect populations. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. Outreach/Collaboration Activities: • Promote partnerships between county, state, and federal agencies to share information and conduct collaborative research on coastal scrub habitat conservation. • Convene another ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize five- and ten-year goals. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public. • Continue educating landowners with properties near pawpaw-occupied protected lands on the benefits of prescribed fire. • Continue using volunteer assistance (e.g., Florida Native Plant Society) and engaging youth in the monitoring and recovery of this species. (USFWS, 2022)

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# SPECIES ACCOUNT: *Astragalus ampullarioides* (Shivwits milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/28/2001; Mountain-Prairie Region (Region 6) (USFWS, 2015)

**Physical Description**

Stems may grow along the ground or to a height of 8-20 in. (20-50 cm), although ungrazed flowering stems may attain a height of 40 in. (1 m). The leaves are pinnately (arranged opposite) compound, 1.6-7.1 in. (4-18 cm) long, and have 11 to 23 elliptical leaflets. Each plant produces approximately 45 small cream-colored flowers about 0.8 in. (2.0 cm) long on a single stalk in the spring. Seeds are produced in small pods, and the plant dies back to its root crown after the flowering season. The fruit is a short, broad pod between 0.3-0.6 in. (0.8-1.5 cm) long and 0.2-0.5 in. (0.6-1.2 cm) wide. (USFWS, 2006)

**Taxonomy**

Kartesz (1999), Isely (1998), and Barneby (1989) do not recognize this entity, at either the species or infraspecific levels, instead including Astragalus ampullarioides (also known as A. eremiticus var. ampullarioides) in A. eremiticus, with no varieties recognized. USFWS and Welsh (1998) recognize at the full species level: A. ampullarioides (Great Basin Naturalist 58(1):51). Barneby (1989) questioned the taxonomic significance of the variety and submerged A. eremiticus var. ampullarioides within typical A. eremiticus. Later research by Harper and Van Buren (1998) and Stubben (1997) demonstrated significant ecological and genetic differences between typical A. eremiticus and A. eremiticus var. ampullarioides. These differences are summarized as follows-(1) A. ampullarioides has more flowers per stem, (2) A. ampullarioides has longer flower stalks (from last leaf to flower), (3) A. ampullarioides has wider pods, (4) A. ampullarioides has taller stems, (5) A. ampullarioides has hollow stems while A. eremiticus stems are solid, and (6) A. ampullarioides plants are highly palatable to grazing animals while typical A. eremiticus is seldom if ever eaten (Barneby 1989; Welsh 1986, 1998; Welsh et al. 1987; Van Buren 1992; Harper and Van Buren 1998). (USFWS, 2006)

**Historical Range**

Historical distribution is not known for either species, that is, records are not available to ascertain whether the current distribution of A. holmgreniorum and A. ampullarioides populations represents either a loss of individual populations or a range contraction for either species. (USFWS, 2006)

**Current Range**

All known locations of A. ampullarioides occur within Washington County, Utah. Known populations of A. holmgreniorum occur within approximately 10 miles (mi) (16 kilometers (km)) of St. George in Washington County, Utah, and Mohave County, Arizona. (USFWS, 2006)

**Critical Habitat Designated**

Yes; 12/27/2006.

**Legal Description**

On December 27, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus ampullarioide (Shivwits milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Utah (71 FR 77972-78012).

**Critical Habitat Designation**

The critical habitat designation for Astragalus ampullarioide includes four CHUs in Washington County, Utah. This species critical habitat encompasses approximately 2,181 acres (2,545 ha) (71 FR 77972-78012).

Unit 1—Pahcoon Spring Wash This unit includes 134 ac (54 ha), all on BLM UT lands adjacent to the Shivwits Indian Reservation. Astragalus ampullarioides was known to occupy this area at the time of listing. This population occurs in a small area where the density of A. ampullarioides is high (Van Buren and Harper 2004b, p. 3). In 2005, this population was estimated to contain approximately 300 to 350 individuals (Van Buren 2005). Unit 1 is determined to be critical habitat because it contains features essential to conservation of A. ampullarioides, is occupied by the species, and represents the northwestern-most occurrence of the species. Resources within this unit support the identified PCEs associated with outcroppings of the Chinle Formation. Special management may be required to minimize disturbance to the surface and subsurface structure within this unit, to control invasive species, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. Cattle grazing activities are present within this unit. The Chinle soils are soft and easily susceptible to erosion. A cost-share agreement between BLM UT and The Nature Conservancy (TNC) provides funding for signs and protective fencing; contracting for the fence is in process. As a part of the agreement, BLM UT and TNC will compare past plant survey data with population surveys to be completed in 2007 and 2009 to evaluate the effectiveness of the fence in eliminating habitat degradation.

Unit 3—Coral Canyon This unit, known to be occupied at the time of listing, is located adjacent to a golf course near Harrisburg Junction, and was estimated to contain 100 individuals in 2005 (Van Buren 2005). Land ownership for the 87 ac (35 ha) is 87 percent SITLA, 12 percent BLM UT, and 1 percent private. We included occupied habitats and adjacent areas of suitable soils and vegetation to allow for maintenance of the seed bank, seed dispersal, and pollinator services. This unit is determined to be critical habitat because it contains features essential to conservation of the taxon, is occupied by the taxon, is centrally located and may provide connectivity between populations, and contains a persistent occupied site of Astragalus ampullarioides. Plants within this subunit face threats from urban development. Special management may be required to minimize disturbance to the surface and subsurface structure within this subunit, maintain the identified soil and vegetation types, and control invasive weeds.

Unit 4—Harrisburg Junction In 2001, the final listing rule (66 FR 49560; September 28, 2001) referred to a population near Harrisburg Junction that contained four separate sites. Unit 4 is comprised of two subunits encompassing 759 ac (307 ha) that are spatially separated based on geography (Harrisburg Bench/Cottonwood and Silver Reef). Each of these subunits contains two of the plant occurrence sites that were known to be occupied at the time of the final listing rule (66 FR 49560; September 28, 2001). In 1999, the 4 sites contained approximately 300 plants (England 1999; Utah Natural Heritage Program 1999; Van Buren 2000). In the area of Harrisburg Junction, Astragalus ampullarioides populations or subpopulations are restricted to outcroppings of the Chinle soil. Each area may be relatively self-sustaining; however, their long-term persistence and stability relies on a balance of site extinctions and colonization of suitable, unoccupied outcroppings through dispersal events (Hanski 1985, p. 341; Olivieri et al. 1990, pp.

207–209; Hastings and Harrison 1994, pp. 175– 176, 180). Subunit 4a—Harrisburg Bench and Cottonwood This 297–ac (120–ha) subunit is 88 percent BLM land and 12 percent private land. Approximately 100 individual plants were located in this subunit during 2005 surveys (Van Buren 2005). This subunit contains PCEs necessary to support Astragalus ampullarioides growth, reproduction, and establishment. Land found between the northbound and southbound lanes of I–15 contains an occupied site. This intervening area within the highway right-of-way may allow pollinator flow between occupied sites (Douglas 2005). Habitat areas between known occupied sites are included in the critical habitat designation to support pollinators and seed dispersal between sites. Pollinator habitat and seed dispersal are considered important for the species' long-term survival (Steffan-Dewenter and Tscharntke 1999, pp. 437–438; Steffan-Dewenter 2003, pp. 1039–1040; Greenleaf 2005, pp. 72–74; Van Buren and Harper 2003a, p. 242). This subunit is determined to be critical habitat because it contains features essential to conservation of Astragalus ampullarioides, is occupied by the species, and contains a persistent occupied site for A. ampullarioides that is centrally located and may provide connectivity between other units. At the Harrisburg site, Bromus tectorum (cheatgrass) is a closely associated species (Van Buren 2005, p. 14). Part of this unit, east of I–15, burned during a wildfire in 2005; however, no suppression occurred in areas of occupied habitat. The status of seeds within the seed bank is unknown. Also unknown, but likely, is that most of the above-ground stems and foliage died back at the time of the fire (Van Buren 2005, p. 14). Revisits in 2006 indicated that Astragalus ampullarioides occupies the site and was not adversely affected by the fire (Van Buren 2006). Plants within this subunit may be threatened by urban development, recreation, and invasive plant species. Special management may be required to control invasive plant species, minimize disturbance to the surface and subsurface structure, and maintain the identified soil and vegetation types. BLM UT and TNC have entered into a cost-share agreement to provide signs and protective fencing to minimize human use at one occupied area within this subunit. Subunit 4b—Silver Reef The 462 ac (187 ha) in this subunit are composed of 90 percent BLM lands and 10 percent private lands. Astragalus ampullarioides individuals are found along intermittent outcroppings of the Chinle Formation. Approximately 150 individuals were identified in a partial survey in 2005 (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of A. ampullarioides, is occupied by the species, contains a thriving population, and maintains a prevalence of soil substrate necessary for future expansion to maintain metapopulation dynamics. Special management may be required to minimize recreational use and disturbance to the soil surface and subsurface structure, control invasive plant species and domestic animals, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Quantitative information on impacts from cattle grazing or recreational use is unknown. One occupied area within this subunit is under a cost-share agreement for protective fencing, which is to begin in the near future. Monitoring will be used to evaluate the effectiveness of the fences in eliminating habitat degradation from cattle and recreational use. Additional areas in this subunit remain unfenced, and special management may still be necessary to reduce impacts to habitat.

Unit 5—Zion The 1,201 ac (486 ha) in Unit 5 occur entirely on lands managed by Zion National Park. The population consisted of approximately 300 to 500 individuals in 2000 (66 FR 49560; September 28, 2001). More recent surveys document almost 4,200 individuals in the unit (Miller 2006). This unit is determined to be critical habitat because it contains features essential to conservation of Astragalus ampullarioides, is occupied by the species, is one of five known populations, represents the northeastern-most range of the species, and contains the largest known population of the species. The land within this unit supports the PCEs necessary for growth, reproduction, and establishment. Special management is necessary in this unit to minimize recreation disturbance to the soil surface and subsurface structure, control invasive weedy species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Recreational use of Zion National Park and disturbance from park visitors and horses may affect Astragalus ampullarioides. An established hiking and horse trail that is used infrequently from November through April occurs near populations of Astragalus ampullarioides. Plants and habitat within this unit also are threatened by invasive nonnative plants, including Moluccella laevis (bells of Ireland), an introduced species not found at other sites. Although this unit is in a sparsely vegetated habitat that in the past did not carry fire, the invasions of exotic grasses are creating more continuous fuels. No management plan exists specific to Astragalus ampullarioides in Zion National Park; however, the current Zion National Park Fire Management Plan includes restrictions on fire management within a 0.75-mi (1.2-km) buffer zone of the area where A. ampullarioides is found. Zion National Park worked with us to complete a recovery plan for the species (71 FR 57557, September 29, 2006), and is partnering with the USGS to investigate biotic soil conditions and invasive weed interactions with A. ampullarioides.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation.  The PCEs of Astragalus ampullarioide critical habitat consists of three components (71 FR 77972-78012):

(i) Outcroppings of soft clay soil, which is often purplish red, within the Chinle Formation and the Dinosaur Canyon Member of the Moenave Formation, at elevations from 920 to 1,330 m (3,018 to 4,367 ft);

(ii) Topographic features/relief, including alluvial fans and fan terraces, and gently rolling to steep swales with little to moderate slope (3 to 24 percent), that are often markedly dissected by water flow pathways from seasonal precipitation; and

(iii) The presence of insect visitors or pollinators, such as Anthophora captognatha, A. damnersi, A. porterae, other Anthophora species, Eucera quadricincta, Bombus morrissonis, Hoplitis grinnelli, Osmia clarescens, O. marginata, O. titus, O. clavescens, and two types of Dialictus species.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

The features essential to the conservation of A. holmgreniorum and A. ampullarioides, in all areas we are designating, may require special management considerations and protections, including measures necessary to alleviate the effects of urban development, retaining plants and their habitat on Federal lands, fencing small populations, removing or limiting access routes, ensuring vehicles and pedestrians stay on designated routes, reducing land use practices that disturb the hydrologic regime, minimizing the effects of grazing and recreation use, managing invasive nonnative plant species, evaluating revegetation and restoration with native plant species, developing adequate fire management buffers for these plant species and their habitat, and educating fire management staff on the location of the plants. Additionally these areas may require special management considerations and protections for ground-nesting and local pollinator communities.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2006)

**Lifespan**

Adult: Unknown; >9 years (USFWS, 2007)

**Dependency on Other Individuals or Species**

Adult: Primary pollinators of A. ampullarioides include the native bees Anthophora coptognatha, A. dammersi, Anthophora spp., Eucera quadricincta, Bombus morrisoni, Hoplitis grnnellei, Osmia clarescens, O. marginata, and O. titusi, as well as the nonnative honeybee Apis mellifera (Tepedino 2005). A. ampullarioides relies solely on the production of seeds for reproduction, and pollination is thus highly linked to the survival of the species. (USFWS, 2007)

**Breeding Season**

Adult: April to May (USFWS, 2007)

**Reproduction Narrative**

Adult: Collection of demographic and life history data for A. ampullarioides began in 1992. A. ampullarioides, a perennial herb, has an unknown lifespan, although tracking of seedlings from 1995 indicates a lifespan of at least 9 years (Van Buren and Harper 2003b). A. ampullarioides does not reproduce through vegetative methods, and their sexual reproduction is contingent on pollen reaching receptive stigmas for seed production. Flowering occurs between April and late May; by the end of June plants dry up, although vestiges of dried plants may persist for several months. Each A. ampullarioides plant is capable of bearing up to 45 flowers per flower stalk (Welsh et al. 2003, 66 FR 49560), and plants frequently have several stalks. From 1992 to 2000, Van Buren and Harper (2003a) documented an average of 86.7 flowers per plant. The number of seeds per pod ranges from 2 to 17, with 7 to 80% of all ovules producing seed (Tepedino 2005). (USFWS, 2006; USFWS, 2007)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Great Basin Pinyon-Juniper Woodland, Colorado Plateau Blackbrush-Mormon-tea Shrubland, Mojave Mid-Elevation Mixed Desert Scrub, Intermountain Basins Mixed Salt Desert Scrub, Sonora Mojave Creosote-Whitebursage Desert Scrub, Intermountain Basins Semi-Desert Shrub Steppe, and North American Warm Desert Lower Montane Riparian Woodland and Shrubland (USFWS, 2007)

**Dependencies on Specific Environmental Elements**

Adult: Adequate rainfall (USFWS, 2007)

**Geographic or Habitat Restraints or Barriers**

Adult: A. ampullaroides populations are found at elevations between 3,018-4,367 ft (920-1,330 m); sparsely vegetated habitat with an average of 12% cover (USFWS, 2007)

**Environmental Specificity**

Adult: Narrow / specialist (USFWS, 2007)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 2007)

**Habitat Narrative**

Adult: A. ampullaroides populations are found at elevations between 3,018-4,367 ft (920-1,330 m), typically on purple-hued patches of soft clay soil of which 99% are associated with isolated outcrops of the Petrified Forest member of the Chinle Formation (Armstrong and Harper 1991; Harper and Van Buren 1997; M. Miller, pers. comm. 2006). This substrate, which is light, airy, and unstable when dry (Van Buren and Harper 2003a), expands greatly with precipitation, becoming slick and glue-like and forming mounds (Harper 1997). Equal contraction upon drying often results in the formation of deep, wide fissures, constricting root systems so that few perennial plants persist on Chinle soils (Harper 1997). A. ampullarioides is documented from the following soil map units described by USDA et al. (1977) C Stony colluvial land; Naplene silt loam, 2-6% slope; Eroded land-Shalet complex; Badland, very steep; Mathis-Rock outcrop complex, 20-50% slope; Rock land, stony; Bond sandy loam, 1-10%; Clovis fine sandy loam, 1-5% slope; Badland; and Rock land Hobog association (USFWS unpubl. data 2005). Soil texture by weight is 48.9% clay, 25.1% silt, and 26.0% sand, with an undetermined depth (Van Buren and Harper 2001). Percentage of gravel and rock on site is much lower than A. holmgreniorum and measures 13.8% (Van Buren and Harper 2003a). A. ampullarioides habitat is sparsely vegetated, with an average 12% cover (Van Buren and Harper 2003a). Due to soil shrinkage and expansion, native plant species found with A ampullarioides are generally herbaceous forbs and grasses including Calochortus flexuosus (sego lily), Dichelostemma pulchellum (bluedicks), Hilaria rigida (galleta), H. jamesii (James' galleta), Sporobolus airoides (alkali dropseed), and Lotus humistratus (hill lotus) (Van Buren and Harper 2003a; M. Miller, pers. comm. 2006). The perennial rootstock allows A. ampullarioides to survive dry years, and in a drought year plants may not emerge (Van Buren and Harper 2003b). Dormancy is one strategy by which longer-lived plant species can survive changing climatic conditions, particularly in relation to rainfall (Epling and Lewis 1952). (USFWS, 2007)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Methods of A. ampullarioides seed dispersal have not been researched. However, water patterns, landscape erosion, and soil slumping likely contribute to the development of appropriate habitat sites and may transport seeds within sites (Van Buren and Harper 2003a). The disjunct populations of A. ampullarioides also could imply bird dispersal (S.L. Welsh, pers. comm. 2005). (USFWS, 2007)

***Population Information and Trends***

**Population Trends:**

Stable (USFWS, 2021)

**Number of Populations:**

6 (USFWS, 2021)

**Population Size:**

4,000-5,000 (USFWS, 2021)

**Population Narrative:**

The latest range-wide estimate for Shivwits milkvetch is 4,000 – 5,000 individuals in six populations; approximately 83 percent of known individuals occur in the Zion population (USFWS, 2021).

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss due to the growing development pressures in the vicinity of St. George and associated infrastructure also threaten A. ampullarioides populations. (USFWS, 2007)

**Stressor:** Recreation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Within the Zion population, a recreational trail poses a potential threat to individuals and habitat, albeit the frequency of habitat disturbance and/or direct plant loss is unknown. Research on user impact has been suggested so that Zion National Park can better manage and assess continuing threats of this species on its lands. (USFWS, 2007)

**Stressor:** Electric power transmission line (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the final listing rule, an electric power transmission line was projected to pass through the Pahcoon Spring Wash and Shivwits A. ampullarioides populations at the western edge of the species' range, as well as through the easternmost population within Zion National Park. Prior to these projects, surveys conducted for this species did not result in any new A. ampullarioides sites being found (L. England, pers. comm. 2006). In response to potential adjacent utility corridor activities, the Shivwits band of the Paiutes fenced the main area of plant occupancy. (USFWS, 2007)

**Stressor:** Silver mining (USFWS, 2007)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Silver mining diminished by the early 1900s (R. Douglas, pers. comm. 2005) and is not believed to be a future threat for A. ampullarioides. Other mining, such as removal of landscaping rock, exists at a distance to the Pahcoon Springs Wash population but does not appear to constitute a threat. (USFWS, 2007)

**Stressor:** Off-road vehicles (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, habitat degradation from ORV use was identified as a threat for A. ampullarioide,s and it continues to be a serious threat, given the increasing popularity of ORV activities in Washington County (see A. holmgreniorum above for more details). The ORV activities in A. ampullarioides habitat are particularly damaging, as the localized clay substrate lacks soil stability and is easily disturbed. The ORV activities lead to associated plant loss, habitat degradation, and changes in native plant communities. Although fencing will not abate all ORV use within A. ampullarioides habitat, fencing at the Pahcoon Spring Wash, Harrisburg Bench and Cottonwood, and Silver Reef population, which is expected to be completed in October 2006, will reduce direct ORV impacts to sites on BLM lands. The Silver Reef population currently experiences the highest levels of ORV use, but a portion of this population has been incorporated into the Red Cliffs Desert Reserve (Washington County Habitat Conservation Plan (HCP), 1995) due to a boundary adjustment (J. Crisp, pers. comm. 2006) and thus will be afforded better protection through site-specific planning for recreational management, recreation use monitoring, and law enforcement. (USFWS, 2007)

**Stressor:** Trampling (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Milk-vetch habitat degradation is caused by cattle trampling, which disturbs the soil surface and seedbanks for these species. This is an issue for the Pahcoon Spring Wash, Shivwits, and Silver Reef A. ampullarioides populations. In particular, the Pahcoon Spring Wash habitat has recently experienced severe cattle trampling (Van Buren 2005), disturbing the fragile clay soils found on the Chinle and Moenave formations and crushing individual plants. Supporting soils are especially susceptible to disturbance and compaction caused by trampling and overuse (R. Van Buren, pers. comm. 2006). In addition to cattle trampling, A. ampullarioides may incur damage during survey efforts if these activities are conducted without sufficient caution. Cattle or human trampling is expected to diminish in the future in light of recently funded fencing projects expected to be completed in October 2006. (USFWS, 2007)

**Stressor:** Fires (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Finally, as described for A. holmgreniorum, St. George, Utah, and surrounding areas are experiencing an increase in fires due to exotic, nonnative grasses such as cheatgrass and red brome. In 2005, fire ran through the Harrisburg Bench site of the Harrisburg Bench and Cottonwood population. Site visits in 2006 documented species presence and indicated a

healthy return. Timing of the 2005 fire coincided with annual plant dormancy patterns, which appears to have reduced detrimental effects (R. Van Buren, pers. comm. 2006). Fires in past years and in 2006 occurred close to the Pahcoon Springs Wash and Shivwits populations on the eastern slopes of the Beaver Dam Mountains. Both BLM and the Tribe are aware of A. ampullarioides population locations and efforts will be made to protect the plants. (USFWS, 2007)

**Stressor:** Development (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Residential and commercial development, which indirectly affects known occupied areas, is occurring at the Coral Canyon population and, to a lesser degree, at the Harrisburg Bench and Cottonwood and Silver Reef populations. (USFWS, 2007)

**Stressor:** Roads (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** New roads, highways, electric power transmission lines, and pipelines were constructed in A. ampullarioides areas prior to the final listing rule and probably caused past impacts on A. ampullarioides populations. For example, the construction of highway I-15 altered the Cottonwood site within the Harrisburg Bench and Cottonwood population areas. not known if additional utility or transportation corridors will be constructed in the future. Current and future highway maintenance (see A. holmgreniorum above for description of projected activities) is a potential threat. (USFWS, 2007)

**Stressor:** Herbivory (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In terms of predation, A. holmgreniorum may be occasionally susceptible to herbivory, while A. ampullarioides is extremely palatable to both wildlife and domestic livestock. Tepedino (2005) indicates losses to herbivores, including cattle for research done at the State Line (A. holmgreniorum) and Coral Canyon (A. ampullarioides) populations; however, this information was not quantified. At the time of listing, livestock grazing at the two western A. ampullarioides populations, Pahcoon Spring Wash and Shivwits, was of concern. However, protective fencing at the Shivwits population has greatly reduced the threat at that site, as will fencing slated to be installed at the Pahcoon Spring Wash in October 2006. (USFWS, 2007)

**Stressor:** Overgrazing (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Overgrazing by livestock can eventually cause a shift in the plant communities, favoring invasive plants to the detriment of both A. holmgreniorum and A. ampullarioides (see Factor E). Recent herbivory at the A. ampullarioides demography study site at Pahcoon Spring Wash population is tentatively attributed to rabbits (Van Buren 2005), although it is not known if

the level of herbivory negatively affects the plants at the population level. Some degree of natural herbivory occurs every year in A. ampullarioides populations (Van Buren 2005). High herbivory was seen in preliminary research conducted in 2006 at Zion National Park, where 90% reduction in fruit production was attributed to vertebrate herbivores. (USFWS, 2007)

**Stressor:** Parasitism and insect infestations (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** One additional factor that warrants further research is the potential for parasitism and insect infestations, particularly in regard to potential effects on A. ampullarioides populations. Past monitoring documented aphid infestations associated with A. ampullarioides. Also, an outbreak of white moths, which visited flowers in April 2005, may have restricted production of seeds. By May, flowers dropped off the stem, inhibiting fruit development, and these symptoms could either be related to white moth predation or to a coincidental lack of pollination. If this reoccurs, it will become a priority for further investigation. (USFWS, 2007)

**Stressor:** Invasive species (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Past habitat disturbance has caused the proliferation of invasive annual weeds into both species' occupied habitat (Harper 1997 and Van Buren and Harper 2000a, 2000b in 66 FR 49560). In fact, all populations of both A. holmgreniorum and A. ampullariodes have been affected to some degree by invasive nonnative annuals, which make up the highest percentage of living cover in the habitat of both species (Van Buren 2004). Because invasive annuals tend to emerge prior to the milk-vetches, competition for soil moisture and nutrients and displacement of the milk-vetches is an emerging threat. (USFWS, 2007)

**Stressor:** Fragmented habitats (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A. holmgreniorum and A. ampullarioides are pollinated by native solitary ground-dwelling bees (Tepedino 2005). Fragmented, disjunct habitats hamper pollinator exchange between populations, which could cause genetic isolation and potentially lead to inbreeding and local extirpation of isolated populations (Heschel and Paige 1995). Urban expansion and associated impacts may directly and indirectly affect pollinators through loss of pollinator habitat (Tepedino 2005). For both species, lack of pollinators would result in a gradual decrease in the number of seeds in the seedbank (Tepedino 2005). Additionally, small and restricted sites of other rare Astragalus were found to receive lower levels of pollinator vistors (Karron 1987). The Gardner Well, Stucki Spring, South Hills, and Purgatory Flat A. holmgreniorum sites are small and disjunct. Similarly, all A. ampullarioides sites, except for Zion, are small and disjunct. (USFWS, 2007)

**Stressor:** Climate change (USFWS, 2007)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Climate change has emerged as a significant concern, particularly in regard to the potential for increasingly prolonged drought cycles (Miller 2005; R. Van Buren, pers. comm. 2006). Both A. holmgreniorum and A. ampullarioides have higher germination and survivorship rates during and following years of increased precipitation (Van Buren and Harper 2003a), and if consecutive years of low reproductive output caused by drought conditions outlast seedbank longevity, the affected populations could become extirpated (R. Van Buren, pers. comm. 2006). Given that drought events occur at a regional scale (Miller 2005), this could prove to be a serious limiting factor for both species. Frost kill also affects both species and could become a more prevalent problem with long-term seasonal changes (R. Van Buren, pers. comm. 2006). (USFWS, 2007)

**Stressor:** Stochastic events (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Additionally, some A. holmgreniorum and A. ampullarioides are small-sized and could be threatened by stochastic events. (USFWS, 2007)

*Recovery*

**Reclassification Criteria:**
1. Species presence is maintained at all recovery populations. (USFWS, 2006)

2. Population trends for four out of six recovery populations of each species are primarily stable or improving, as indicated by occupied habitat, density of occupied habitat, and predictive modeling. (USFWS, 2006)

3. The habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations. (USFWS, 2006)

4. Population and habitat management is implemented for all recovery populations of each species in accordance with site-specific management plans. (USFWS, 2006)

5. Permanent land protection is achieved for at least four recovery populations of each species. (USFWS, 2006)

6. Site-specific conservation agreements are in place for all recovery populations and their habitat to protect these milk-vetches within existing State laws. (USFWS, 2006)

7. The conservation of these species is included in a long-term State plant conservation agreement. (USFWS, 2006)

8. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within A. ampullarioides and A. holmgreniorum recovery populations. (USFWS, 2006)

9. For at least four recovery populations of each species, effective measures are in place to control potential negative effects on invasive nonnative species that could harm these milk-vetches and/or their habitats. (USFWS, 2006)

10. The protected habitat base for at least four recovery populations of each species is large enough to offset loss or restriction of the species' pollinators. (USFWS, 2006)

11. Use of pesticides or herbicides detrimental to either of the milk-vetches or their pollinators is prohibited in the vicinity of all recovery populations. (USFWS, 2006)

12. Research indicates genetic fitness, alleviating concern about inbreeding or outbreeding depression. (USFWS, 2006)

13. Seed collection/storage is underway for all extant A. holmgreniorum and A. ampullarioides populations. (USFWS, 2006)

Recovery Priority Number: 5C

**Delisting Criteria:**

1. Two additional populations of each species are either located or successfully introduced to habitat in proximity to extant populations. Thus, a minimum of eight recovery populations will be needed to delist each species. (USFWS, 2006)

2. The available habitat base for each newly discovered or introduced recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and among populations. (USFWS, 2006)

3. Population trends for all A. holmgreniorum and A. ampullarioides recovery populations are primarily stable or improving, as indicated as indicated by species presence, occupied habitat, density of occupied habitat, and demographic modeling. (USFWS, 2006)

4. Each of the eight A. holmgreniorum and eight A. ampullarioides recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective. (USFWS, 2006)

5. Permanent land conservation is achieved for all recovery populations whether extant or introduced (a minimum of 8 populations), such that Endangered Species Act (ESA) protection is no longer needed to compensate for regulatory inadequacies. (USFWS, 2006)

6. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within all A. ampullarioides and A. holmgreniorum recovery populations. (USFWS, 2006)

7. A long-term offsite conservation program is ongoing for all milk-vetch recovery populations. (USFWS, 2006)

**Recovery Actions:**

- Conserve known extant A. holmgreniorum and A. ampullarioides populations and their habitat. (USFWS, 2006)
- Locate and conserve additional extant populations, if any. (USFWS, 2006)
- Monitor A. holmgreniorum and A. ampullarioides sites for population information and trends. (USFWS, 2006)
- Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers. (USFWS, 2006)
- Develop and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations. (USFWS, 2006)
- Augment extant populations and/or establish new populations of each species in accordance with the rangewide strategy. (USFWS, 2006)
- Promote effective communications with partners and stakeholders regarding the milk-vetches' recovery needs and progress. (USFWS, 2006)
- Develop and implement educational and outreach programs. (USFWS, 2006)
- Develop and implement educational and outreach programs. (USFWS, 2006)
- Establish a technical working group to regularly review the status of the species and track the effectiveness of recovery actions. (USFWS, 2006)
- Revise the recovery program when indicated by new information and recovery progress. (USFWS, 2006)
- In collaboration with interested local, State, and Federal agencies, institutions, and Indian Tribes, BLM will prepare conservation agreements and strategies designed to stabilize declining populations, and will promote protective management to ensure survival of the species. (USFWS, 2007)
- To reduce conflicts and additional disturbance, habitat areas will be designated as rights-of-way avoidance areas and closed to fuelwood and mineral material sales. Plants will be protected by restricting mountain bike use and off-road vehicle travel to designated roads and trails. (USFWS, 2007)
- Prior to surface-disturbing exploration or development associated with fluid mineral leasing, botanical surveys will be completed and known populations avoided to eliminate the taking of plants. (USFWS, 2007)
- Habitat areas will be kept free from use of chemical pesticides and herbicides. (USFWS, 2007)
- Where necessary to protect small isolated populations of Hermit's milk-vetch (aka Shivwits milk-vetch) under 10 ac (4 ha) in size, BLM will fence areas to prevent inadvertent destruction of plants. (USFWS, 2007)

***Conservation Measures and Best Management Practices:***

- Recommendations on species status: After reviewing available scientific information and recovery criteria, we conclude that Shivwits milkvetch remains an endangered species. Our review of new information compiled since 2007 does not change our evaluation of the species status and threats affecting the species under the factors in 4(a)(1) of the Act from our most recent 5-year review (Service 2007). The downlisting and delisting criteria for Shivwits milkvetch are not met (Service 2006a). Therefore, we recommend no change in status. (USFWS, 2021)

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USFWS. 2021. 5-Year Review Short Form Species Reviewed: Shivwits milk-vetch (Astragalus ampullarioides). 6 pp.

# SPECIES ACCOUNT: *Astragalus applegatei* (Applegate's milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/27/1993; Pacific Southwest (R8)

**Physical Description**

A tap-rooted, herbaceous, perennial plant. The numerous tufted or trailing stems are 2.5-8 decimeters (10-33 inches) long, simple or branching, and may be smooth or have sparse stiff, short hairs. Leaves are 3.5-12 centimeters (1.5-5 inches) long, are on petioles, and have 7-1 1 linear to linear-elliptic flat leaflets, the terminal one usually the longest. Racemes typically bear 5-20 pea-like flowers with lavender-tipped white petals. The 8-13 millimeters (0.4-0.6 inches) long, stalked fruit pods are oblong, compressed, have short hairs and frequently have green or purple speckled valves. Pods split apart from the top (dehisce apically)then downward through the ventral suture, and contain up to 10 (but usually fewer than 3) dark brown minutely dotted seeds with depressions. (USFWS, 1998)

**Taxonomy**

Member of the Fabaceae (pea family). First discovered near Klanlath Falls, Oregon, in 1927 by Morton Peck. Peck subsequently collected the species 2 miles (3.2 kilometers) east of Keno, Oregon, in 1931 and then described It (Peck 1936). It was thought to be extinct until its rediscovery in 1983 by James Kagan of theOregon Natural Heritage Program (Kagan 1983).(USFWS, 2009).

**Historical Range**

Endemic to the Lower Klamath Basin, in Klamath County, Oregon, about fifteen miles north of the Oregon-California border. (USFWS, 1998)

**Current Range**

Lower Klamath Basin, in Klamath County, Oregon (USFWS, 2019a)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual; self-fertilization and crossing occur (NatureServe, 2015)

**Dependency on Other Individuals or Species**

Adult: Plebejus melissa (USFWS, 2009)

**Breeding Season**

Adult: June - September (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Possibly other insect pollinators (USFWS, 1998)

**Reproduction Narrative**

Adult: Reproduction is sexual; self-fertilization and crossing occur (4/98 Recovery Plan) (NatureServe, 2015). Flowers are present from June to September. The Melissa blue butterfly (Plebejus melissa) is a specific known pollinator (58 FR 40548). Despite ample production of viable seeds, very few Applegate's milk-vetch seedlings have been observed in native populations. Applegate's milk-vetch plants have eight to ten ovules per pod that can mature into seeds; however, it is rare that more than three do so (USFWS 1998) (USFWS, 2009). Applegate's milk-vetch is visited by numerous insects, with prominent visitors including bumble bees (Apidae: Bombus spp.), other polylectic bees (Megachilidae: Osmia spp.; Andrenidae: Andrena spp.), bee-flies (Bombylidae), and the butterflies Lycaedes argyrognomon (Yamamoto 1985) and Plebejus melissa (ODA, unpublished) (USFWS, 1998).

**Habitat Type**

Adult: Terrestrial, wetland, riparian (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Floodplain grasslands (NatureServe, 2015); interior alkali grassland (USFWS, 2009)

**Dependencies on Specific Environmental Elements**

Adult: Probably periodic flooding (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs ~1250 m elevation (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (USFWS, 2009)

**Habitat Narrative**

Adult: Inhabits flat seasonally moist remnants of alkaline floodplain grasslands of the Klamath Basin, at about 1250 meters. The substrate is poorly drained fine silt loam (an underlying hardpan impedes drainage). Prior to irrigation and water control along the Klamath River, periodic flooding probably limited the dominance of other species and provided openings for establishment of Astragalus applegatei (NatureServe, 2015). This species is limited to a very specific soil regime resulting in a very specific habitat type. The vegetative community in which Applegate's milk-vetch sites occurs is classified as interior alkali grassland (TNC 1999). Soils in typical Applegate's milk-vetch habitats are characterized as being gray in color, slightly alkaline, with a shallow water table and groundwater with a relatively high salinity due to periodic flooding and evaporation (TNC 1999). The soils on these sites belong to the Henley, Laki, and Poe series with inclusions in the Calimus series, and are very deep, coarse-loamy, mixed superlative, mesic Haplic Durixeroll (TNC 1999). A weakly developed duripan at 127 to 254 inches is usually present and accounts for the pooled surface water during the spring at most sites (TNC 1999) (USFWS, 2009).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 1998)

**Dispersal/Migration Narrative**

Adult: Fruits shed their seed shortly after flowering and exhibit no specialized mechanisms for long-distance seed dispersal. Some seed dispersal may take place through ingestion by rodents or jackrabbits, although this has not been documented. Localized seed dispersal is supported by field observations, which document that the majority of seedling establishment is immediately adjacent to mature plants (Yamamoto 1985, Oregon Department of Agriculture [ODA]unpublished) (USFWS, 1998).

***Population Information and Trends***

**Number of Populations:**

8 (USFWS, 2019a)

**Population Size:**

!80,000 individuals (USFWS, 2019a)

**Population Narrative:**

Ongoing demographic monitoring of naturally occurring populations is providing data related to life stages and survival rates (Byrnes 2017b). The discovery of additional occupied sites through opportunistic observation increased the total number of known sites from two in 1993 to the current number of eight, although the current status of two smaller sites is uncertain (USFWS 2019a). Based on previous survey results, populations at four of the eight known sites appear to suggest population stability or growth. Population of a fifth site appears to be declining while the status of the remaining three populations is uncertain due to lack of data (USFWS 2019a). 2019 preliminary survey results from the Collins site also suggest site population stability and growth (J. Spaur, personal communication 7/17/19). Three of the sites are privately owned, two are state owned, one is city owned, and one is owned by an environmental organization for the purpose of Applegate's milk-vetch conservation. (USFWS, 2019a)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The final rule states that irrigation and water control along the Klamath River have eliminated the seasonal flooding that once occurred along floodplains supporting the species. While some adverse affects cannot be ruled out from this hydrologic alteration, declines appear to be mostly due to declines appear to be mostly due to other factors. Agricultural and urban development has resulted in widespread depletion, fragmentation, and modification of Applegate's milk-vetch habitat, to the extent that even small (an acre or less) parcels of truly undisturbed habitat are uncommon (USFWS 1998). Habitat loss and modification from both urban and commercial development and expansion are still the most significant threats to the species within its historic range. At the Klamath Falls Airport, there are plans to expand and develop the area where the largest occurrence of Applegate's milk-vetch is currently found. The airport is currently filling in wetlands around the perimeter of the property to reduce bird

collisions with the air traffic where milk-vetch occurs. Additionally, the airport has plans to expand runways, build more hangers, and is looking to alter areas to provide better drainage along runways (USFWS, 2009).

**Stressor:** Herbivory (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In 1991 and 1992, ORNHIC (2007b) noted that the Miller Island population was struggling due to rabbit grazing. In 2007, ORNHIC reported observations of jack rabbit pellets at several Applegate's milk-vetch sites at Miller Island (ORNHIC 2007a). Jack rabbits are plentiful at the Klamath Falls Airport site as well (Hancock, pers. comm. 2007). As a result of seed collection efforts, Oregon Department of Agriculture reported that the reduced seed output of Applegate's milk-vetch in 2002 appeared to be caused by predispersal seed predation by insects. Most seed pods showed damage by insects and the seed collection bags were littered with the bodies of seed weevils and beetles (Gisler 2002a). Limited seed production coupled with seed predation may be significantly affecting the reproductive opportunities of Applegate's milk-vetch occurrences but additional studies are needed to determine population-level effects. Cattle are currently grazed at the Collins site and it has been documented that cattle do consume this species. Herbivory from insects includes the larvae of the Melissa blue butterfly. The larvae of the Melissa blue butterfly have been observed defoliating Applegate's milk-vetch plants and chewing through large plant stems near their bases (Gisler and Meinke 2001). Herbivory is not likely a major threat to the species, but when combined with the limited distribution and population size of Applegate's milk-vetch, habitat loss or modification due to herbivory and seed predation on this species could have a negative impact on its reproductive output and therefore recovery (USFWS, 2009).

**Stressor:** Nonnative plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat colonization by non-natives could indirectly limit Applegate's milk-vetch by increasing input of plant litter and nitrogen fixation by introduced legumes, and creating conditions favorable to secondary succession by shrubs and other herbaceous species historically restricted by harsh, bare soils (USFWS 1998). Likewise, habitat colonization by weeds, especially thatch-forming grasses, could promote greater densities of voles and other potential plant herbivores and granivores through increased cover and protection from predators (USFWS 1998). Thatch-forming grasses are also problematic for this species because it's difficult for seedlings to germinate and penetrate the thatch layer. All of the extant occurrences of Applegate's milk-vetch have some non-native weeds present. Elitrigia or Elytrigia repens (creeping quackgrass), Lactuca serriola (prickly lettuce) and Apera interrupta (dense silky bent) are just a few of the weed species found at Applegate's milk-vetch sites. Creeping quackgrass is present at the Ewauna Flat Preserve, Miller Island and Washburn Way-Railroad sites. The Miller Island and Klamath Falls Airport sites are mostly dominated by planted Thinopyrum intermedium (intermediate wheatgrass) (ORNHIC 2007a). Non-native plants at the Klamath Falls Airport site include: Agropyron cristatum (crested wheatgrass), intermediate wheatgrass, Poa bulbosa (bulbous bluegrass) and Holosteum umbellatum (jagged chickweed) (ORNHIC 2007a), although these species do not occur in high densities. Low densities of weedy species have also been observed at

the Collins Tract site, but of particular concern at this site is Hordeum murinum (mouse barley) and Cirsium spp. (thistles) (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The final rule for Applegate's milk-vetch states that with the small number of occurrences, and small number of individual plants for each occurrence, there is an increased potential for extinction from stochastic events such as flood or fire. The limited gene pool may depress reproductive vigor or a single human-caused or natural environmental disturbance could destroy many of the individuals of this species. There is no information available about the genetic diversity of the few occurrences of this species (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** State-level protections do not apply to private lands. Federal protections under the Clean Water Act may not be protective. (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. A minimum of four self-sustaining populations/sites are under protected management3 for the benefit of the species. Includes the development of an Applegate's milk-vetch management plan addressing the mitigation and prevention of stressors and threats including agricultural and urban development (Factor A); wildlife and cattle grazing (Factor C); lack of regulatory protection (Factor D); and poor reproduction, competition with exotic weeds, seed predation, and low population viability (Factor E). (USFWS, 2019)

2. For a site to contribute as a self-sustaining population/site, a minimum of 2,200 reproductive plants need to be present at the site over five consecutive years of monitoring. (USFWS, 2019)

Recovery Priority Number: 5

**Delisting Criteria:**
1. A minimum of four self-sustaining populations/sites are under secured management7 for the benefit of the species or six self-sustaining recovery populations/sites are under protected management for the benefit of the species. Habitat being managed for Applegate's milk-vetch under the oversight of long-term land ownership that is not expected to change (e.g., the Miller Island recovery area that is owned by the State and managed as a Wildlife Management Area or the Airport property owned and managed by the City). (USFWS, 2019)

2. A minimum of 2,200 reproductive plants occurring over five consecutive years of monitoring at each site that contributes toward the delisting threshold. (USFWS, 2019)

**Recovery Actions:**

- Conserve natural and introduced Applegate's milk-vetch populations. The heart of recovery efforts for Applegate's milk-vetch will be to: 1) increase the species' representation from the current three areas to at least six areas with a minimum of two populations occurring at each of the recovery areas; and 2) develop management strategies that provide for long-term stability. (USFWS, 1998)
- Long-term, off-site seed storage. Banking (long-term cryogenic storage) of Applegate's milk-vetch seeds will provide an additional level of security to the recovery and survival of the species, by creating a demographic and genetic reserve of plant propagules. Off-site seed storage may be particularly vital in instances when natural soil seed banks are depleted due to poor seed production and pre- and post-dispersal seed mortality, or destroyed by natural or anthropogenic catastrophe. Stored seeds may be useful in establishing and augmenting Applegate's milk-vetch populations, mitigation of future population losses, and potential sources of genetic variability in the event populations suffer from inbreeding depression and/or allele fixation through drift. (USFWS, 1998)
- Conduct further research. The following areas of research must be addressed to increase our knowledge about the nature and extent of Applegate's milk-vetch threats, and improve the species' prospects of recovery. Define population self-sustainability. Perfect population establishment and augmentation techniques. Assess efficacy of habitat management strategies. Edaphic and hydrologic requirements. (USFWS, 1998)
- Develop and implement an outreach program. Increasing public awareness of Applegate's milkvetch will facilitate efforts to preserve this plant and restore its habitat. Prepare informational brochures, audiovisual, and sign programs on habitat restoration and recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities such as National Wildlife Refuge interpretive programs and school programs. (USFWS, 1998)
- Recommended Future Action: While our Applegate's milk-vetch knowledge has increased substantially since its listing, much remains unknown regarding the species' life stages and resource requirements. Demographic monitoring efforts are currently ongoing for both naturally occurring populations and outsourced plants, including the collection of survivorship and life stage data. Data analysis for the first three years of the natural population survival study returned results for seedling survival at 11.5% for year one and 8.5% for year two. Work is needed to determine methods to increase seedling survival rates. (USFWS, 2019a)
- Recommended Future Action: Another key remaining research question is the identification of the species or group of species of mycorrhizae that are necessary for Applegate's milk-vetch survival. Once we know how to identify the species/group of species, we'll be able to more successfully determine where future transplanting should occur, as we'll be able to test if the mycorrhizae/other potentially important soil microbiota are present in the soil. The Service will also gain a better understanding of how and when it colonizes milk-vetch roots. Preliminary efforts have been initiated but additional study is needed. (USFWS, 2019a)
- Recommended Future Action: The Service believes that the highest priority actions during the next five years are to determine methods to increase seedling survival rates and to identify the species/group of species of mycorrhizae that are necessary for Applegate's milk-vetch survival. The next highest research priorities are those focusing on genetic or pollinator studies. Therefore, the Service recommends that current efforts continue and that additional methods are developed and implemented toward answering these highest

priority research questions. (USFWS, 2019a)

- Recommended Future Action: The Service also periodically receives new information about potential sites where Applegate's milk-vetch may have been seen. It is recommended that the Service survey these sites, to the extent that there is access. (USFWS, 2019a)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: To work towards delisting, the Service recommends implementing a plan for annual surveying of ASAP populations, including indication of life stage, for all populations close to reaching the benchmark of 2,200 reproductive individuals. Surveys for other populations are recommended at least once every five years, also with indication of individual life stage. All surveys should also include a habitat condition and composition component. Previous research results indicate the need for additional study related to ASAP restoration and management. The Service recommends the continued research of population reinforcement and the role of AMF communities related to ASAP as restoration tools and to explore the response of ASAP to various management options, including fire, mowing, and scraping. As mentioned above, a current research collaboration between ODA, ODPR, HSU, and the Service is underway at the OC&E site to 1) census and map the entire OC&E site ASAP population; 2) collect baseline abundance information on the species through establishment of plots; 3) apply experiment management treatments that may foster population growth; 4) monitor responses to the treatments; 5) collect soil samples and sequence microbiome to characterize soil microbiome associations and habitat characteristics; 6) analyze data; and 7) report findings. Results are preliminarily expected in 2025 with a final report in 2026 (ODA, 2023). (USFWS, 2024).

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# SPECIES ACCOUNT: *Astragalus bibullatus* (Guthrie's (=Pyne's) ground-plum)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 9/26/1991; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A low perennial herb with a stout taproot bearing 5-10 simple, glabrous, slender stems, 5-15 cm long. Leaves are alternate and pinnately compound with small leaflets. Flowering stems are 5-8 cm long, ascending with purple, pea-shaped flowers in compact clusters of 10-16 and blooming in April and May. Fruits are plump, fleshy globe shaped pods that ripen in May and lie on the ground, becoming red on the side facing the sun and yellow on the bottom. In the summer, the pods dry to stiff, 2-valved papery pods with flattened small dull black seeds (Somers and Gunn 1990). (NatureServe, 2015)

**Taxonomy**

Specimens that are now assigned to A. bibullatus were apparently first collected as early as 1881 by the Tennessee botanist, Augustin Gattinger. For over 100 years, this material was assigned to A. crassicarpus, a related but morphologically and geographically distinct species that occurs approximately 750 kilometers (466 miles) to the west. Milo Pyne discovered the Rutherford County, Tennessee, site in 1979, which later became the type locality for the species. Botanists familiar with the genus Astragalus determined that the plants found by Pyne might represent a new species. In 1985, flowering and fruiting material from the type locality was sent by Jerry Baskin to Rupert Barneby, a monographer of the genus at the New York Botanical Garden. Barneby concluded that this was a new species, A. bibullatus, and described it with Edwin Bridges (Barneby and Bridges 1987). Kartez (1994) recognizes A. bibullatus as the correct name for plants in Tennessee (USFWS, 2011a).

**Historical Range**

Astragalus bibullatus is endemic to the cedar glades of middle Tennessee (USFWS, 2011a).

**Current Range**

Extant occurrences are located in the Stones River watershed in the vicinity of Murfreesboro, Rutherford County, Tennessee (USFWS, 2011a).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (EPA, 2016)

**Dependency on Other Individuals or Species**

Adult: Insect pollinators (Bees) (USFWS, 2024)

**Breeding Season**

Adult: April - May (USFWS, 2011b)

**Other Reproductive Information**

Adult: Most pollinators that have been documented for A. bibullatus are species of bees, a taxonomic group experiencing a global decline in diversity (USFWS, 2024)

**Reproduction Narrative**

Adult: Flowering occurs April to May and fruiting occurs May to June. Obligate sexual reproduction most likely occurs via insect pollination (USFWS, 2011b).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Limestone cedar glade ecosystems; barrens, forest edge, forest/woodland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Partial shade (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 500 - 700 ft. elevation (USFWS, 2011b)

**Spatial Arrangements of the Population**

Adult: Clumped (see population narrative)

**Environmental Specificity**

Adult: Narrow to moderate (inferred from USFWS, 2011a)

**Habitat Narrative**

Adult: Limestone cedar glade ecosystems in the Middle Tennessee Central Basin. The plants are associated with Lebanon limestone and occur in transitional areas or glade margins where the soils are deeper (5-15 cm) and there is partial shade from shrubs and small trees. Environmental conditions in limestone glades are extreme - wet in the spring and very dry in the summer (NatureServe, 2015). Occurs between 500 to 700 ft. elevation. Soil types generally associated with rock outcrops in Rutherford County are the Gladeville and Talbott series (USFWS, 2011b). It should be noted that the most recently discovered occurrence was found in a small opening in a closed cedar forest, suggesting the potential for long-term persistence of A. bibullatus in less than ideal conditions provided that habitat is not destroyed (USFWS, 2011).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are dispersed by gravity and water (USFWS, 2011b).

***Population Information and Trends***

**Population Trends:**
Decline of 10-90% (NatureServe, 2015)

**Species Trends:**
Stable (USFWS, 2011a)

**Number of Populations:**
12 extant wild, 9 extant reintroduced (USFWS, 2024)

**Population Size:**
The number of individuals at most of these occurrences ranges in the tens to hundreds; only one occurrence has been observed to consist of greater than 1,000 individuals (USFWS, 2019)

**Adaptability:**
Low (inferred from USFWS, 2011a)

**Additional Population-level Information:**
Since the 2019 5-year review (Service 2019, entire), when there were 12 known extant occurrences of Astragalus bibullatus, 9 additional occurrences have been established through reintroductions. As of 2024, there are 21 occurrences of Astragalus bibullatus, 12 of which exist as the result of introductions established by outplanting nursery-grown juvenile plants (Table 1). In addition, there are two wild occurrences that have been augmented with outplanted individuals to increase abundance. More than 1,600 individuals of A. bibullatus were outplanted across these introduced or augmented occurrences, and there were 761 surviving plants across these sites as of 2023, representing both planted individuals and plants recruited from reproduction in the wild since the time of outplanting (USFWS, 2024).

**Population Narrative:**
It is known from three extant populations. Two populations of Astragalus bibullatus (collected in 1901 and 1948 respectively) are believed to have been extirpated (USFWS 1991). This species has experienced a long-term decline of 10-90% (NatureServe, 2015). The species status is stable based on the 2011 Recovery Data Call. It is presently known from 8 extant occurrences. The extant occurrences of A. bibullatus are typically small, consisting of tens to hundreds of individuals (Table 1). Only one occurrence has ever been estimated to include greater than 1,000 individuals. Morris et al. (2002) surmised that, because of environmental changes, A. bibullatus populations were reduced in size and gene flow among them was likely restricted, leaving them vulnerable to effects of genetic drift and inbreeding. An occurrence that TVA biologists discovered during a 2006 survey of a powerline right-of-way extended the currently known range approximately 16 km (10 mi) to the southwest and expanded the area encompassing the species’ current range to approximately 235 km2 (90 mi2) (USFWS, 2011).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2011a)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** All the occurrences of Astragalus bibullatus are within a short distance of the rapidly growing middle Tennessee city of Murfreesboro. Five of the occurrences are located on public lands and as such are protected from development threats. However, the three remaining occurrences are located on private lands where development pressures are great. Limestone cedar glades are relatively flat and clear areas that often attract developers. One occurrence (population 2 in the listing rule) has been either destroyed or significantly altered by commercial development since A. bibullatus was listed and is now believed to be extirpated. Habitat degradation due to ORV use of sites on private lands remains a potential threat, as does illegal ORV use on sites protected by public ownership (USFWS, 2011a).

**Stressor:** Invasive species (USFWS, 2011a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** All the known Astragalus bibullatus occurrences are threatened by the encroachment of more competitive herbaceous vegetation and/or woody plants, such as eastern red cedar, that produce shade and compete for limited water and nutrients. Invasive exotic species that currently are either being managed or have been noted as potential threats at A. bibullatus occurrences include spotted knapweed (Centaurea biebersteinii), Japanese honeysuckle (Lonicera japonica), privet (Ligustrum spp.), and sericea lespedeza (Lespedeza cuneata), among others. Active management to reduce or eliminate vegetation encroachment is required to ensure that the species continues to survive at all the sites (USFWS, 2011a).

**Stressor:** Herbivory (USFWS, 2011a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory has been observed to varying degrees during monitoring of A. bibullatus occurrences. Albrecht and McCue (2010) observed that some spring transplants were browsed, and Walck (2007) observed herbivory or signs of it at three sites (USFWS, 2011a).

**Stressor:** Climate change (USFWS, 2011a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service identified extended drought conditions as a threat to Astragalus bibullatus, because of the likely reduced resilience of the three small populations that were known at the time of listing to endure such stochastic environmental events (56 FR 48750, Service 1991). The occurrence of severe drought in middle Tennessee, during the summers of 2007 and 2008, provides an opportunity to assess effects of drought to populations that are periodically monitored. It is possible that alterations in precipitation and drought frequency or severity that might accompany climate change could pose a growing threat to A. bibullatus in the future. Estimates of the effects of climate change using available climate models lack the geographic precision needed to predict the magnitude of effects at a scale small enough to discretely apply to the range of Astragalus bibullatus. However, data on recent trends and predicted changes for the Southeast United States (Karl et al. 2009) provide some insight for evaluating the potential threat of climate change to A. bibullatus. Since 1970, the average annual

temperature of the region has increased by about 2o F, with the greatest increases occurring during winter months. The geographic extent of areas in the Southeast region affected by moderate to severe spring and summer drought has increased over the past three decades by 12 and 14 percent, respectively (Karl et al. 2009). These trends are expected to increase. Rates of warming are predicted to more than double in comparison to what the Southeast has experienced since 1975, with the greatest increases projected for summer months. Depending on the emissions scenario used for modeling change, average temperatures are expected to increase by 4.5o F to 9o F by the 2080s (Karl et al. 2009). While there is considerable variability in rainfall predictions throughout the region, increases in evaporation of moisture from soils and loss of water by plants in response to warmer temperatures are expected to contribute to increased frequency, duration, and intensity of droughts (Karl et al. 2009) (USFWS, 2011a).

**Stressor:** Population fragmentation (USFWS, 2011a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small population sizes and fragmentation of cedar glade habitats could influence genetic structure of Astragalus bibullatus populations. As noted above, Morris et al. (2002) concluded that the among-site genetic structure they detected within the youngest soil seed layers of A. bibullatus occurrences was likely attributable to an increased incidence of inbreeding over time, due to the isolation of populations caused by fragmentation. They surmised that, because of increased fragmentation of cedar glade habitats and increased shading due to vegetation encroachment in those that remain, A. bibullatus populations were reduced in size and gene flow among them was likely restricted, leaving them vulnerable to effects of genetic drift and inbreeding (USFWS, 2011a).

***Recovery***

**Reclassification Criteria:**
There are 11 viable, protected occurrences distributed throughout the cedar glade ecosystem of the Stones River Basin within Davidson, Rutherford, or Wilson counties (USFWS, 2011a).

Recovery Priority Number: 2

**Delisting Criteria:**
There are 16 viable, protected occurrences that are distributed throughout the cedar glade ecosystem of the Stones River Basin within Davidson, Rutherford, and Wilson counties (USFWS, 2011a).

**Recovery Actions:**
- Protect and manage existing occurrences and habitats (USFWS, 2011b).
- Search for new occurrences (USFWS, 2011b).
- Conduct long-term monitoring and assess population growth rates and viability (USFWS, 2011b).
- Conduct biological and ecological research (USFWS, 2011b).
- Develop protocols for establishing new occurrences or augmenting existing ones (USFWS, 2011b).

- Communicate with local officials to coordinate city and county planning (USFWS, 2011b).
- Develop and implement public education materials (USFWS, 2011b).
- Periodically assess the success of recovery efforts for the species (USFWS, 2011b).
- Federal and state regulatory protection (USFWS, 2011b).
- Investigating the species' biology, ecology, and life history (USFWS, 2011b).
- Preserving germplasm and establishing or augmenting occurrences (USFWS, 2011b).
- Site protection and management (USFWS, 2011b).
- Surveys and monitoring (USFWS, 2011b).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS A. Continue to pursue protection and/or cooperative management for occurrences located on privately owned lands. Highest priority should be given to protecting or managing the Rockvale site (EO 18), due to its genetic distinctiveness relative to other occurrences throughout the species range. Demographic monitoring also should be conducted for EO 18. B. Coordinate with private landowners to gain permission for collecting seed to preserve germplasm representing currently unprotected occurrences. Collect seed from these sites to add to existing accessions held at MBG. C. Determine whether redundant seed accessions are needed, in order to eliminate potential for losing all germplasm currently held in ex situ collections. If they are not currently established, coordinate with MBG to establish redundant accessions at another facility. D. Implement site-specific management recommendations listed below. Note that recommended timing for prescribed burns is November through mid-February. When prescribed burns are conducted late in this timeframe, pre-burn inspections should be conducted to determine whether spring growth has been initiated in A. bibullatus. If plants are found to be actively growing, measures should be taken to remove fuels from the immediate vicinity of A. bibullatus plants to prevent damaging them. Site-specific Recommendations Davis site (EO 5) – This small population, semi-protected on private land, has low viability but apparently contains some unique alleles. Albrecht and Dell (2019) recommended applying judicious and light manual thinning of eastern red cedar trees staggered over several years to avoid potential impacts of drought. They also recommend the collection of seeds and seed banking for possible use in augmentation at the adjacent Overbridge DSNA. Augmentation attempts should be staggered over several years. Overbridge DSNA (EO 4) – As of 2018, this is a very small population with only six non-reproductive individuals and is not likely to have positive population growth without augmentation. In recent years, thinning of eastern red cedar and prescribed burning have been conducted on the natural area; however, tree canopy cover remains >50% (Albrecht and Dell 2019). MBG recommends augmentation of this population using material from the adjacent Davis site to increase population size. Genetic material from Flat Rock Cedar Glades and Barrens DSNA could also be used if needed. Manus Road Glade DSNA (EO 9) – Population dynamics are more variable at this site; however, the long-term trend is projecting a population decline. It is possible that the low population growth rate is in response to multiple interacting variables such as herbivory, drought, and untimely application of a spring prescribed burn (Albrecht and Dell 2019). Management at this site has been more active over the last six years especially with thinning woody encroachment and use of prescribed fire. Albrecht and Dell (2019) recommended that no management occur for a period of 2-3 years to see how the population recovers. Herbivore exclusion plots were established here in 2018. Prescribed fires should be conducted during the dormant season (November to mid-February) at an interval of > 5 years. Recent fires were too close together (March 2016-Fall 2017) and likely resulted in high mortality for seedling and small juvenile plants (Albrecht and Dell 2019). Flat Rock Cedar Glades and Barrens DSNA – • Airport site (EO 1a) – This site contains the largest population of A. bibullatus and the highest population growth rates. The population is near demographic equilibrium (i.e., population growth models indicate that demographic structure is sufficient to maintain a stable population, $\lambda \approx 1$) and has high survival rates for both small and large plants, and Albrecht and Dell (2019) recommended continuing to mow this site with a bush hog every 5-10 years from late June to December. This site has less woody canopy cover than other sites and experienced the lowest population growth rates during drought years when most other sites showed higher growth rates (Albrecht and Dell 2019). • Alexander site (EO 1b) – This site is across the road from the Airport site and has similar characteristics. Woody encroachment has been steadily increasing at this site and, therefore, Albrecht and Dell (2019) recommended continued mowing every 5-10 years from late June to December. • Davenport East site (EO 3a) – This small population is completely surrounded by forest despite thinning of woody vegetation and management with prescribed burning. It is near demographic equilibrium but expected to slowly decline. Albrecht and Dell (2019) recommended creating a large canopy gap around the A. bibullatus population through selective removal of canopy trees like eastern red cedar and non-oak species. Dormant season burning of the surrounding woodland may also promote population expansion. Because an herbivore exclusion plot was established here in 2018, Albrecht and Dell (2019) recommended delaying management for 2-3 years. • Davenport West site (EO 3b) – This site has been managed with woody encroachment thinning and prescribed burning. Despite its small size, the population is near demographic equilibrium. Albrecht and Dell (2019) recommended management to expand the size and spatial extent of the suitable habitat to increase population resilience to environmental change. This may be accomplished with dormant season prescribed burning every 6- 10 years. Small population augmentations may also be needed to hedge against the loss of large adult plants, which currently dominate the population. (USFWS, 2019)

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan for Pyne's ground-plum (Service 2011b). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities Continued management is needed to restore or maintain habitat conditions for long-term population growth at A. bibullatus occurrences. The recovery plan calls for developing and implementing adaptive management plans for each occurrence. General management plans that identify goals and procedures for management of limestone glade habitats exist for state-owned conservation lands where A. bibullatus occurs. To achieve recovery criteria, these management plans should include specific goals and objectives related to A. bibullatus conservation, an adaptive management strategy, and a commitment of resources for achieving them. To be adaptive, these plans should incorporate a framework for using available monitoring data to assess when and where management actions are needed and to evaluate the species response to management actions and environmental variation. Management plans should also be prepared for sites on private lands where landowners are willing to manage habitat for A. bibullatus recovery. Monitoring and Research Activities Continued long-term demographic monitoring as outlined in the recovery plan is needed to effectively gage resiliency of wild and introduced occurrences to environmental variation, assess when and where management actions are needed, and understand how management influences demography and, therefore, resiliency. A rigorous analysis of available demographic monitoring data would improve our understanding of how population dynamics are influenced by environmental variation and effects of habitat management and facilitate identification of sitespecific management actions that would reduce threats and promote stable or increasing growth trends. A monitoring program to track pollinator diversity and abundance in limestone glades is needed to improve understanding of how variation in pollinator abundance and rates of visitation to A. bibullatus influences reproductive output in populations. (USFWS, 2024)

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# SPECIES ACCOUNT: *Astragalus brauntonii* (Braunton's milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 02/28/1997; Pacific Southwest (R8)

**Physical Description**

A robust, short-lived perennial in the pea family (Fabaceae) (Hickman 1993). It is one of the tallest members of the genus, reaching a height of 1.5 meters (5 feet) and is covered with fine, entangled hairs throughout. The stems are white, the leaves pale to greenish. A thick taproot and woody basal stem gives rise to several stems. The 4 to 16 centimeters (1.5 to 6.5 inches) long leaves are pinnately compound with 25 to 33 oblong-ovate, abruptly pointed leaflets. The light purple flowers are clustered in 35 to 60 flowered racemes (flowers are borne on stalks) 4 to 14 centimeters (1.5 to 5.5 inches) long. The beaked, slightly curved pods are oblong-ovoid, 6.5 to 9 millimeters (2.5 to 3.5 inches) long and two-celled, front to back, with three to six seeds. Astraga/us brauntonii is readily distinguished from the only other perennial species ofAstraga/us in the area, A. trichopodus, by being woolly tomentose (covered with densely matted hairs) as opposed to strigose (covered with sharp, stiff-appressed hairs) or glabrous (without hairs), and by the twochambered, rather than one-chambered pods (Barneby 1964). (USFWS, 1999)

**Taxonomy**

Member of the pea family (Fabaceae) (USFWS, 2009). Astragalus brauntonii was described by Samuel Parish (1903) based on a specimen collected by Dr. H. E. Hasse in 1899 above Santa Monica. It was named for Ernest Braunton. Per Axel Rydberg published the name Brachyphragma brauntonii in his revision of the genus. However, Rydberg’s fragmentation of the genus Astraga/us has not been accepted by other botanists. Systematic treatments (Bameby 1964) and floristic treatments (Munz 1974, Spellenberg 1993) recognized Parish’s original treatment of this taxon (USFWS, 1999).

**Historical Range**

See Current Range.

**Current Range**

Occurs in five disjunct geographic areas in Ventura, Los Angeles, and Orange Counties, California (USFWS, 2009). The occurrences can be grouped into four areas: the Santa Monica Mountains, the south slope of the Simi Hills, the San Gabriel Mountains near Monrovia, and the Santa Ana Mountains. At the time of listing in 1997 (Service 1997), A. brauntonii was described as being found in the same four general areas, with 6 occurrences distributed among those areas. The recovery plan identified 20 occurrences (it combined EO# 15 and EO# 17, and listed an EO# 21 which is not currently recognized; Service 1999 pp. 8–10). The critical habitat designation (Service 2006) did not list occurrences, and the 2009 5-year review did not add any new occurrences (USFWS, 2023).

**Critical Habitat Designated**

Yes; 12/14/2006.

**Legal Description**

On November 14, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 14, 2006) for Astragalus brauntonii (Braunton's milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (71 FR 66374-66423).

**Critical Habitat Designation**

The critical habitat designation for Astragalus brauntonii includes six CHUs (including 10 subunits) in Ventura, Orange and Los Angeles Counties, California. Approximately 3,300 acres (ac) (1,337 hectares (ha)) fall within the boundaries of the critical habitat designation. The critical habitat is located in Ventura, Los Angeles, and Orange Counties, California. Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule. (USFWS, 2006).

Unit 1: Northern Simi Hills Unit: This unit is located south of Simi Valley in the northern Simi Hills in Ventura County and consists of 21 ac (9 ha) of local agency land (Rancho Simi Recreation and Parks District) and 413 ac (166 ha) of private lands. It is divided into four subunits mapped from occurrences identified after the time of listing but currently occupied; all occur within 1.5 mi (2.5 km) of each other. Unit 1, inclusive of the four subunits, is located within the same physiographic area (the Simi Hills) as Unit 2.

Unit 2: Southern Simi Hills Unit: This unit is located along the southern Simi Hills in Ventura and Los Angeles Counties and consists of 196 ac (80 ha) of Federal lands, 118 ac (48 ha) of State land, 427 ac (173 ha) of local agency lands (Conejo Open Space Conservation Authority (COSCA), City of Thousand Oaks, Santa Monica Mountains Conservancy, and Rancho Simi Recreation and District), and 278 ac (113 ha) of private land. This unit is divided into six subunits mapped from records known at the time of listing and occurrences identified after listing. These subunits are all within 3.2 mi (5.2 km) of each other and occur along the southern perimeter of the geologic Chatsworth Formation.

Unit 3: Santa Monica Mountains Unit: This unit is located in the eastern Santa Monica Mountains in upper Zuma Canyon, north of Point Dume in Los Angeles County. It consists of 172 ac (70 ha) of Federal land within the Santa Monica Mountains National Recreation Area, and 56 ac (23 ha) of private land. It includes an area where more than 300 plants were found in 1999 after a prescribed burn, and the entire unit is mapped from an occurrence identified after listing.

Unit 4: Pacific Palisades Unit This unit is located in the Santa Ynez Canyon north of Pacific Palisades in Los Angeles County and consists of 439 ac (178 ha) of State lands within Topanga State Park and 66 ac (27 ha) of private land. It includes plants found in three separate locations that are part of a single population complex, and is mapped from occurrences known at the time of listing.

Unit 5: Monrovia Unit This unit is located in the San Gabriel Mountains in the City of Monrovia in Los Angeles County and consists of 218 ac (88 ha) of local agency land owned by the City of Monrovia and managed as open space (Monrovia Wilderness Preserve) and 64 ac (26 ha) of private land. It includes plants found in several locations that are part of a single population complex, and is mapped from an occurrence known at the time of listing.

Unit 6: Coal Canyon Unit This unit is located south of the City of Yorba Linda in Coal Canyon and Gypsum Canyon in Orange County and consists of 589 ac (238 ha) of State land (Chino Hills State

Park and California Department of Fish and Game—Coal Canyon Ecological Reserve) and 243 ac (98 ha) of private land. This unit includes plants found in several locations that are part of a large population complex, and is mapped from occurrences known at the time of listing.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus brauntonii critical habitat consists of three components (71 FR 66374-66423):

(i) Calcium carbonate soils derived from marine sediment;

(ii) Low proportion (less than 10 percent) of shrub cover directly around the plant; and

(iii) Chaparral and coastal sage scrub communities characterized by periodic disturbances that stimulate seed germination (e.g., fire, flooding, erosion) and reduce vegetative cover.

**Special Management Considerations or Protections**

Threats that may require special management are specified in the Final Rule for each Critical Habitat Unit: Unit 1. Road maintenance, which could result in disturbances that are too frequent and prevent replenishment of the seed bank, invasion of nonnative plants which could crowd out A. brauntonii, cattle grazing, and recreation activities such as equestrian and foot traffic, which could result in trampling of plants. Unit 2: Road and trail maintenance that could result in disturbances that are too frequent and prevent replenishment of the seed bank, invasion of nonnative plants that could crowd out Astragalus brauntonii, edge effects from urban development, and recreation activities such as off-road vehicles and equestrian and foot traffic, which could result in trampling of plants. Subunit 1c is threated by additional part development. Unit 3: Road maintenance that could result in disturbances that are too frequent, preventing establishment or replenishment of the seed bank. Unit 4: Road maintenance that could result in disturbances that are too frequent, preventing establishment or replenishment of the seed bank, and growth of nonnative plants that could crowd out Astragalus brauntonii. Unit 5: Maintenance of fire roads, the growth of nonnative plants that could crowd out Astragalus brauntonii, and recreation activities such as foot and bicycle traffic, which could result in trampling of plants. Unit 6: Maintenance of fire roads and the growth of shrubs and nonnative plants, which could crowd out Astragalus brauntonii. (USFWS, 2006)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: self-fertilization, cross-pollination (USFWS, 2009)

**Lifespan**

Adult: 2 - 3 years (NatureServe, 2015); possibly 5+ years in favorable conditions (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Fire/disturbance (NatureServe, 2015); insect pollinators (bees known), soil seed bank (USFWS, 2009)

**Reproduction Narrative**

Adult: The seeds germinate after fire or other disturbance and the plants live only 2-3 years before senescing (NatureServe, 2015). A. brauntonii is self-fertile, but also produces seed through cross-pollination (Fotheringham and Keeley 1998). Known pollinators include megachilid bees (Ashmeadiella spp.) and bumblebees (Bombus spp.) (Fotheringham and Keeley 1998). Disturbances such as fire, erosion, and mechanical scraping of soil (e.g., during road or trail maintenance) are known to stimulate germination (Fotheringham and Keeley 1998). Each plant may support upwards of several hundred flowers, and each seed pod produces three to six seeds (Barneby 1964), therefore, each plant can produce a large number of seeds which are deposited in the soil (seed bank). Individual plants have a lifespan of two to three years, although some individuals may live five years or more if conditions are favorable, and then plants are not visible again until the next disturbance (Fotheringham and Keeley 1998) (USFWS, 2009).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Brush/chaparral (NatureServe, 2015); coastal sage scrub (USFWS, 2009)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire; interval unknown (possibly 20 - 100+ years) (USFWS, 1999)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs ~800 - 2,100 ft. elevation, shade-intolerant (USFWS, 2009)

**Spatial Arrangements of the Population**

Adult: Patchy (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2009)

**Habitat Narrative**

Adult: Brush/chaparral communities. The natural frequency of fire in the species' habitat is unknown. The plants may be restricted to limestone substrates (NatureServe, 2015). The species appears to be limited to shallow calcium carbonate soils derived from marine substrates; it occasionally occurs on non-carbonate soils at down-wash sites near other known occurrences, although survivorship of plants may be reduced on noncarbonate soils (Mistretta 1992, Fotheringham and Keeley 1998, Landis 2005). Astragalus brauntonii is associated with chaparral and coastal sage scrub plant communities and generally occurs along the tops of knolls ranging from 800 to 2,100 ft. (244 to 640 m) in elevation (Fotheringham and Keeley 1998, CNDDB 2007, Landis 2005). The habitat has been described as scrub dominated by chaparral with a high overall percentage (>80 percent) of vegetative cover, however, the species does not tolerate shading and is associated with surrounding bare ground (Carroll 1987, Fotheringham and Keeley 1998). It requires a low proportion (<10 percent) of shrub cover directly around the plant. Many of the plant species that comprise chaparral and coastal sage scrub communities regenerate after fire, either through the release of a dormant seed bank whose germination is stimulated by fire, or through basal burl sprouting (Hanes 1971, Keeley and Zedler 1978). The above-ground expression of A. brauntonii populations are patchy over time and space as a result of the dormant seed bank and are subject to the dynamic habitat conditions and physical processes where it occurs (USFWS, 2009). The natural fire interval in the habitat of. brauntonii is unknown. Estimates range from 20 to more than 100 years, with an average of 70 year intervals (Minnich 1989; O'Leary 1990) (USFWS, 1999).

***Dispersal/Migration***

**Dispersal**

Adult: Low to moderate (inferred from USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: Neither the fruits or the seeds have specialized adaptations to facilitate seed dispersal by wind; therefore, it is likely that most seeds fall within a short distance of the parent plant (Cain et al. 2000). Long-distance dispersal, however, is likely achieved by water (during rainstorms), and by transport of seeds by wildlife. Small mammals facilitate seed dispersal through consumption and elimination of undigested seed and through seed caching (Cain et al. 2000, Sieg 1987) (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

57 EOs. 52 extant (USFWS, 2023)

**Population Size:**

Variable; tens to thousands per population, depending on disturbance cycle (USFWS, 2009)

**Population Narrative:**

This plant is only visible for a short time following disturbance such as a fire (NatureServe, 2015). There are currently 20 known occurrences. In most cases, the number of plants within a population is in the hundreds to thousands following a disturbance, and declines to fewer than ten plants within a few years (CNDDB 2007). (USFWS, 2009). Currently, the California Natural Diversity Database (CNDDB) recognizes 57 Element Occurrences (EOs, Table 1, CDFW 2023) of A. brauntonii. An EO is a group of plants separated by at least 400 meters (1/4 mile) from the closest group of plants of the same species (CNDDB 2018 entire). The occurrences can be grouped into four areas: the Santa Monica Mountains, the south slope of the Simi Hills, the San Gabriel Mountains near Monrovia, and the Santa Ana Mountains. At the time of listing in 1997 (Service 1997), A. brauntonii was described as being found in the same four general areas, with 6 occurrences distributed among those areas. The recovery plan identified 20 occurrences (it combined EO# 15 and EO# 17, and listed an EO# 21 which is not currently recognized; Service 1999 pp. 8–10). The critical habitat designation (Service 2006) did not list occurrences, and the 2009 5-year review did not add any new occurrences (Service 2009). Most of the occurrences (52 of 57, Table 1) are presumed by CNDDB to be extant, and most of the presumed extant occurrences (39 of 52) may be at least partly on land managed for resource conservation. Most of the occurrences are in the Santa Monica Mountains and Simi Hills (22 and 24 respectively), with only 4 in the San Gabriel Mountains and 7 in the Santa Ana Mountains (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Land management actions that result in frequent disturbances, such as yearly road maintenance where Astragalus brauntonii occurs, may be contributing to the decline of populations by mowing and removing plants before seeds mature and replenish the seed bank. This has been known to occur for plants along unpaved fire access roads and utility corridors. Other land management activities such as herbicide application, cattle grazing, and recreational activities such as off-road vehicle and equestrian use that results in trampling of plants may be affecting A. brauntonii. Of the currently known 20 occurrences, the Service is unaware of protections for the 6 occurrences on private lands and for 4 of the 8 occurrences on local agency lands, and therefore presumes they could be threatened by indirect or direct effects from existing or future urban development, recreational activities, or other land management activities. Since the time of listing, one occurrence in Oak Park on lands owned by Rancho Simi Recreation and Parks District was extirpated due to park expansion. Another occurrence was partially removed by the Ventura County Public Works Agency for creation of a detention basin, and the remaining portion of this occurrence has been proposed for development into the Lang Ranch Community Park by Conejo Recreation and Park District (USFWS, 2009).

**Stressor:** Altered fire cycles (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** One threat to Astragalus brauntonii discussed in the listing rule is the impact of fire management policies over the last 200 years on southern California ecosystems. The listing rule stated that fire exclusion has resulted in an accumulation of fuels in woody vegetation, making fire intensity and duration more severe. However, wildlands near urban areas have been experiencing increased fire frequencies, resulting in vegetation changes from shrub to grass and facilitating the spread of non-native, invasive annual plants. Despite efforts to suppress fires in coastal southern California, the current fire frequency of every 15 years or less, is substantially higher than it was historically, which is thought to be every 50 to 100 years (Keeley 2006). The impacts of fire suppression and/or increased fire frequencies near urban areas on Astragalus brauntonii are unclear. As of 1997, the Service believed that fire suppression activities resulted in the extirpation of A. brauntonii during the Old Topanga fire of 1993 (Service 1997); however, more recent surveys have revealed plants growing in that area (CNDDB 2007). Extirpation of populations is unlikely as long as habitat remains, although above-ground plants may cease to grow for many years until a disturbance stimulates dormant seeds to germinate. Therefore, A. brauntonii habitat that has undergone succession and is dominated by dense woody shrubs may not be harmful to the long-term persistence of the plant as long as periodic disturbances are allowed to occur (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Astragalus brauntonii may be vulnerable to extirpation by stochastic factors including demographic stochasticity, environmental stochasticity, and genetic stochasticity (Shaffer 1981). Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of A. brauntonii. In most cases, the number of plants within a population is in the hundreds to thousands following a disturbance, and declines to fewer than ten plants within a few years (CNDDB 2007). The disjunct distribution of A. brauntonii decreases genetic exchange between populations, which could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor) (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service recognizes that climate change is an important issue with potential effects to listed species and their habitats. While the Service lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Astragalus brauntonii, small ranged species, such as Astragalus brauntonii, may be more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2009).

**Stressor:** Trampling (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Occurrences on both private and public lands are subject to damage from trampling of plants from activities including hiking, mountain biking, off-highway vehicle use, equestrian use, and, in a few cases, grazing. In some situations, the disturbance of these activities can stimulate germination of an existing soil seed bank, with the resulting plants succumbing to trampling before being able to produce seeds. Trampling by recreational use remains a threat to the species when trails cross through occurrences (USFWS, 2023).

**Stressor:** Pollination Reduction (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The recovery plan (Service 1999 p. 10) and critical habitat designation (Service 2006 p. 66387) listed a reduction in pollinators because of habitat fragmentation as a possible threat. A pollination study (Fotheringham and Keeley 1998 pp. 14–15) found that the species selfpollinates and produces seeds at a rate not significantly different than if it is open to visitation by generalist bees. The study did not investigate the genetic consequences of the lack of pollination by other A. brauntonii within or between occurrences. There could be local inbreeding effects if there was no effective pollen transfer between occurrences, but this remains to be investigated. The magnitude of the threat of reduction of pollinators is unclear (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
1. All 20 current populations are fully protected (including seed banks), and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 1999)

2. Seed is securely stored and plants are successfully germinated from collected seed and/or historic sites e.g. propagation techniques for reintroduction are developed. (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**
1. When monitoring shows that the habitat is secure; provisions for ecological requirements exist; and conditions for the species indicate stability over a minimum of 15 years. This 15 years of monitoring will be extended by an additional 5 years of monitoring which is required by the Endangered Species Act for newly listed species. (USFWS, 1999)

**Recovery Actions:**
- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).
- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)

- Recommendations for Future Actions from 2009 5-Year Review: 1) Work with private landowners and local agencies to protect and manage habitat for Astragalus brauntonii. This may be accomplished by conservation easements or other permanent devices. 2) Work with local agencies, fire departments, and utility companies to ensure that maintenance activities, such as grading of roads and/or mowing along dirt fire access roads and utility corridors, do not negatively impact Astragalus brauntonii. This includes conservation measures such as waiting until seeds mature to cut plants, and depositing plants and seeds on-site so that they replenish the seed bank. 3) Examine genetic diversity in the species and incorporate that data into the sampling and maintenance methodologies for seed banking called for in the recovery plan. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct thorough population census surveys of all known occurrences and areas of suitable habitat, especially in the San Gabriel Mountains and Santa Ana Mountains areas. These surveys are needed to accumulate baseline information about distribution so that it can be compared with distribution after wildfire or other disturbance. 2. Develop and implement a monitoring plan for all occurrences. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. Monitoring data should be in place so that comparisons can be made if at future dates the monitoring areas burn. 3. Review protective measures in place for all occurrences on public lands. 4. Work with public and private entities to prevent damage to plants and raise public awareness to support appropriate conservation measures. 5. Develop a method to assess the number of seeds in the soil seed banks of occurrences, and test how that relates to numbers of plants that germinate after disturbance. 6. Increase the number of accessions in conservation seed banks so that a greater number of known occurrences are represented and add accessions for previously collected occurrences so that a greater number of years is represented (USFWS, 2023).

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# SPECIES ACCOUNT: *Astragalus clarianus* (Clara Hunt's milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/22/1997; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A slender, sparsely leafy annual herb, mostly 7-12 cm in height. Flowers (March-April) are bicolored, with the wings whitish and the banner and keel bright purple-tipped (NatureServe, 2015).

**Taxonomy**

Name generally spelled "clarianus" (e.g., by Barneby (Astragalus), Kartesz 1994 and 1999, Hickman 1993, and USFWS); has also appeared as the strictly Latinized version "claranus" but that spelling does not appear to be in current usage (NatureServe, 2015). A member of the pea family (Fabaceae) (USFWS, 2009).

**Historical Range**

Historically, Clara Hunt’s milkvetch was known from six occurrences in Sonoma and Napa counties (Service 1997, p. 55792). It is possible that this plant has always been rare, but more common in the hills surrounding the Napa Valley and possibly on the valley floor itself, before the planting of vineyards (Service 2019, p. 3). By the time of listing in 1997, two of the known occurrences had been extirpated due to urbanization and viticulture, leaving only one occurrence in eastern Sonoma County (Diversity Database #3 - Saint Helena Road) and three occurrences in northwestern Napa County (Diversity Database #7 - Bothe-Napa Valley State Park, Diversity Database #11 - Lake Hennessey, and Diversity Database #12 - Lewelling Lane) (Service 1997, p. 55792). As noted in the 2009 status review, one additional occurrence of Clara Hunt’s milkvetch was discovered in 1998 within Spring Valley (Diversity Database #13) in Napa County, approximately 3.2 kilometers (2 miles) east of Lake Hennessey (Service 2009, p. 3). At the time of the 2019 status review, the species was still known from these five occurrences; however, the status of the Bothe-Napa Valley State Park occurrence was uncertain as no plants had been observed at the site since 2009 despite multiple survey attempts (USFWS, 2024).

**Current Range**

Highly limited today due to development of vineyards and urbanization (NatureServe, 2015). The species is currently known from five localities in Napa county and Sonoma county (USFWS, 2009). The species is restricted to six localities in northwestern Napa County and eastern Sonoma County. Habitat destruction and modification due to urbanization and competition from invasive plant species pose the most significant threats to this species (USFWS, 2024).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2009)

**Breeding Season**
Adult: March - April (USFWS, 2009)

**Reproduction Narrative**
Adult: Flowers from March through April (USFWS, 2009).

**Habitat Type**
Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**
Adult: Manzanita and oak woodlands (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**
Adult: 75 - 225 m elevation (NatureServe, 2015)

**Environmental Specificity**
Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**
Adult: Openings in manzanita and oak woodlands, on thin, rocky clay soils derived from volcanic materials or on serpentine substrates. Occurs at 75 - 225 m elevation (NatureServe, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**
Adult: Not available

***Population Information and Trends***

**Population Trends:**
Not available

**Species Trends:**
Declining (NatureServe, 2015)

**Number of Populations:**
6 (USFWS, 2024)

**Population Size:**
>2,000 (USFWS, 2024)

**Population Narrative:**
Only about 500 total plants in normal year. This species is declining due to habitat modification (USFWS 1997) (NatureServe, 2015). Currently, three occurrences support fewer than 100 individuals (CNDDB 2008) (USFWS, 2009). The species is restricted to six localities in northwestern Napa County and eastern Sonoma County. Habitat destruction and modification

due to urbanization and competition from invasive plant species pose the most significant threats to this species (USFWS, 2024). In 2021, two Clara Hunt's milkvetch plants were found at the Bothe-Napa Valley State Park occurrence (Bjerke 2021, p. 3). The reappearance of Clara Hunt's milkvetch at this occurrence after its absence for over a decade may be attributed to the 2020 Glass Fire (Bjerke 2021, p. 2). The 2021 survey of the occurrence found that patches of habitat had burned at low intensity and most of the woody debris and herbaceous layer had been burned away in the immediate vicinity of the two Clara Hunt's milkvetch plants (Bjerke 2021, p. 2). The Saint Helena Road and Saddle Mountain/Hayfork Ranch occurrences were also within the perimeter of the 2020 Glass Fire (Watershed Emergency Response Team 2020, p. 20). The distribution of the species at both of these occurrences expanded the year following the fire (Bjerke in litt. 2024). All Clara Hunt's milkvetch plants observed at the Saint Helena Road occurrence in 2021 were found in areas that burned during the Glass Fire or that were bulldozed to create a fire break (Bjerke 2021, p. 4). A total of approximately 2,300 plants were observed at the Saddle Mountain/Hayfork Ranch occurrence the year following the fire (Bjerke 2021, p. 4). This is one of the largest population sizes recorded for the species (Bjerke 2021, pp. 3–4; Diversity Database 2024, entire). Fifty-three plants were counted on the Saddle Mountain Open Space Preserve and approximately 1,000–2,500 plants were present within the adjacent portion of the occurrence on Hayfork Ranch (Bjerke 2021, p. 3). The smaller, occupied area to the west on Hayfork Ranch was estimated to contain approximately 500 plants (Bjerke 2021, p. 4). In 2022 and 2023, the species was present at the Saint Helena Road and Saddle Mountain/Hayfork Ranch occurrences in similar densities, which were more abundant than prior to the Glass Fire (Bjerke in litt. 2024; Delmartini in litt. 2024) (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The loss and modification of habitat via development, recreational activities and uprooting by feral pigs continues to threaten this species, especially in areas where urbanization is expected to expand further. Three populations are located on private lands where potential development is not precluded; the general trend of habitat loss due to urbanization has continued and will likely continue at or adjacent to known populations (USFWS, 2009).

**Stressor:** Competition with introduced species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Centaurea solstitialis (yellow star-thistle) has infested the Lake Hennessey and Bale Grist Mill populations and threatens A. claranus via competition for resources. The threat posed by introduced species may become more sever with climate change. The Lewelling Lane population is threatened by competition from Genista monospessulana (French Broom) (CNDDB 1996). Based on its annual habit and size, it is thought that A. claranus has difficulty competing with introduced annual grasses (Howald, in litt. 2008) (USFWS, 2009).

**Stressor:** Community succession (USFWS, 2009)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Plant succession at Bale Grist State Historic Park is excluding or reducing the population of A. claranus (Ruygt 1994). Fire suppression has reduced fire frequency, allowing new manzanita seedlings to become established, which results in less space available for A. claranus (USFWS, 2009).

**Stressor:** Small population size (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Having few individuals leaves A. claranus susceptible to extirpation throughout a significant position of its range from random events and increases the threat of genetic drift and inbreeding. Therefore, this species is threatened with extinction or extirpation throughout a significant portion of its range due to random events such as flood, drought, disease, or other events (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While the particular impacts of climate change on A. claranus have not been investigated, evidence suggests that the distribution of appropriate habitat elements (microclimate, community associations) may be altered in the coming decades resulting in a further decline of the species (USFWS, 2009).

**Stressor:** Pesticides (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. The overall importance of pollinating insects for Clara Hunt’s milkvetch is poorly understood (Ruygt 1994, p. 45; Department 2019, p. 5). However, bee pollination is a common mode of pollination in the milkvetch genus (Astragalus) (Watrous and Cane 2011, Table 1, pp. 228–229) and bees have been observed visiting Clara Hunt’s milkvetch plants (Liston 1992, p. 376). The Agency’s final biological evaluations determined that all three pesticides are highly toxic to bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Clara Hunt’s milkvetch, there is a potential for the three pesticides to indirectly adversely affect the species (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**

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

Recovery Priority Number: 5C

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

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- Complete a recovery plan for Astragalus claranus (USFWS, 2009).
- Develop habitat suitability model for Astragalus claranus and then project anticipated shifts in range and occurrences under various climate change scenarios (USFWS, 2009).
- Secure landowner agreements with property owners at the Lake Hennessey, Spring Valley, Lewelling Lane and St. Helena Road populations to facilitate the management of Astragalus claranus habitat to reduce or eliminate competition with introduced plant species and uprooting by feral pigs (at Lewelling Lane) (USFWS, 2009).
- Conduct three consecutive years of surveys at each of the five localities to better understand population sizes and inter-annual population fluctuations. Surveys should also include an assessment of current threats facing the A. claranus populations (USFWS, 2009).
- Work with California Department of Parks and Recreation at Bale Crist Mill State Historic Park to manage habitat (e.g., conduct introduced species control) near the A. claranus population in the park (USFWS, 2009).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS Here we propose several habitat conservation and management recommendations which will aid in the recovery and conservation of the Clara Hunt's milkvetch. Some of these recommendations have already been discussed in previous Service recovery documents (Service 2009, p. 13; Service 2019, p. 2) or were identified during the Department's 5-Year Status Review of the species (Department 2019, p. 25) and remain valid. 1. Secure landowner agreements with property owners for the Lake Hennessey, Spring Valley, and Lewelling Lane occurrences to protect the occurrences from development and facilitate the management of Clara Hunt's milkvetch habitat to reduce or eliminate competition with introduced plant species and uprooting by feral pigs, if still an issue at Lewelling Lane. 2. Conduct annual demographic monitoring at all six localities. Monitoring surveys should also include an assessment of current threats facing the Clara Hunt's milkvetch at each locality. 3. Collect seeds from the Bothe-Napa Valley State Park and Saddle Mountain/Hayfork Ranch occurrences and request that the California Botanic Garden conduct seed viability tests on previously collected seeds. Seeds were collected from the other four occurrences of Clara Hunt's milkvetch in 2009 and are stored at the California Botanic Garden. 4. Work with California Department of Parks and Recreation at Bothe-Napa Valley State Park to manage habitat (e.g., vegetation removal, introduced species control, prescribed burns) occupied by Clara Hunt's milkvetch. If habitat management efforts do not result in growth and reproduction of the species, discuss the possibility of implementing population augmentation with the California Department of Parks and Recreation and the California Department of Fish and Wildlife. 5. Conduct coordinated research or adaptive management to identify effective habitat management techniques for maintaining Clara Hunt's milkvetch habitat (preventing community succession) and controlling invasive plant species. 6. In collaboration with the City of Napa, investigate ways to reduce impacts from recreational use, invasive species, and

remnant topsoil piles at the Lake Hennessey population (USFWS, 2024).

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# SPECIES ACCOUNT: *Astragalus lentiginosus var. piscinensis* (Fish Slough milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Southwest (R8) (USFWS, 2016) The Fish Slough milkvetch (Astragalus lentiginosus var. piscinensis) was originally listed on October 6, 1998 as threatened (63 FR 53596) and critical habitat was designated on June 9, 2005 (70 FR 33774). The Service completed a recovery plan that addresses the species (Service 1998), and a 5-year review in 2009 (Service 2009). In the 5-year review, the Service determined that no change was needed to the classification as threatened.

**Physical Description**

A perennial herb with a few hairy, branched, prostrate stems radiating from a central rootstock. Stems can be as long as 1 m and individual plants can occupy a 2.7 square m area. Leaflets are reduced to only two lateral pairs with an elongate terminal leaflet longer than the leaf stalk. The flowers, arranged in loose racemes, are pale lavender and number from 5 to 12 per inflorescence. Loose clusters of pale lavender flowers bloom in late spring. Fruits are brightly mottled, strongly inflated, leathery pods, with a complete septum and an incurved beak (USFWS 1998NatureServe, 2015). Fish Slough milk-vetch is distinguished from other varieties of Astragalus lentiginosus by its three to five linear-oblanceolate leaflets, and its densely strigose, strongly inflated pods (Barneby 1977).

**Taxonomy**

Astragalus lentiginosus var. piscinensis was described by Barneby (1977) based on a collection made by Mary DeDecker in 1974, from BLM Spring, Fish Slough, northwest of Bishop, California. Spellenberg (1993) retained this variety in his treatment of Astragalus for the Jepson Manual, and no other changes in taxonomic classification or nomenclature have been made since then. (USFWS, 2009) Dicot.

**Historical Range**

At the present, Astragalus lentiginosus var. piscinensis is restricted to the same range as it was at the time of listing, a 10 kilometer (6 mile) stretch of alkaline flats paralleling Fish Slough. The slough supports the species on less than 540 acres (219 hectares; USFWS 2009).

**Current Range**

Restricted to a 10-kilometer mile stretch of alkaline flats paralleling Fish Slough, Mono County, California. (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 6/9/2005.

**Legal Description**

On June 9, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus lentiginosus var. piscinensis (Fish Slough milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (70 FR 33774-33795).

**Critical Habitat Designation**

The critical habitat designation for Astragalus lentiginosus var. piscinensis includes one CHU Mono and Inyo Counties, California. In total, approximately 8,007 acres (ac) (3,240 hectares (ha)) fall within the boundary of the critical habitat designation (70 FR 33774-33795).

Mono Counties, California. From USGS 1:24,000 quadrangle maps Chidago Canyon and Fish Slough, California.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus lentiginosus var. piscinensis critical habitat consists of four components (70 FR 33774-33795):

(i) Alkaline soils that occur in areas with little or no slope, and which overlay a groundwater table that is 19 to 60 in (48 to 152 cm) below the land surface;

(ii) Plant associations dominated by Spartina-Sporobolis, or where a sparse amount of Chrysothamnus albidus occurs in the transition zone between Spartina-Sporobolis and Chrysothamnus albidus-Distichlis plant associations;

(iii) The presence of pollinator populations for Astragalus lentiginosus var. piscinensis; and

(iv) Hydrologic conditions that provide suitable periods of soil moisture and chemistry for Astragalus lentiginosus var. piscinensis germination, growth, reproduction, and dispersal.

**Special Management Considerations or Protections**

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

When designating critical habitat, we assess whether the physical and biological features determined to be essential for conservation may require special management considerations or protection. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In 1982, BLM established the Fish Slough ACEC in an effort to provide protection for the federally endangered Owens pupfish, several rare plant taxa including Astragalus lentiginosus var. piscinensis, and the wetland and riparian habitats upon which these species depend. The Fish Slough ACEC has three zones (BLM 1984). The designated critical habitat unit is predominantly located within Zone 1 of the ACEC, includes a very small portion of Zone 2, and also extends slightly beyond the southern boundary of the ACEC. The land in Zone 1 is owned by BLM, CDFG, LADWP, and one private landowner. The portion of the designated critical habitat unit in Zone 2, or in the area immediately south of the ACEC, is owned by BLM or LADWP. A management plan for the ACEC was finalized in 1984, but the plan has not been revised since it was completed. Previously identified threats to Astragalus lentiginosus var. piscinensis include the presence of roads, effects related to the use of OHV, effects related to cattle grazing, and effects from herbivory by native vertebrates and insects (Service 1998). A potential threat to A. l. var. piscinensis not previously identified in other documents includes competition with, or displacement by, nonnative plant species (P. Hubbard, LADWP, pers. comm. 2003). The modification of wetland habitats that results from groundwater pumping or water diversion activities altering the surface and underground hydrology of Fish Slough is also a threat to the species (Service 1998). The suite of threats affecting Astragalus lentiginosus var. piscinensis is complex. The establishment of the Fish Slough ACEC has helped provide some benefit for A. l. var. piscinensis by coordinating the activities of staff from BLM, LADWP, and CDFG on various land management challenges that exist in the local area. Because the long, narrow configuration of the slough is bounded by upland habitat, the amount of alkaline habitat that can be occupied by A. l. var. piscinensis is limited. Ferren (1991b) summarizes threats to botanical resources at Fish Slough, noting that those threats related to the enhancement of fisheries (construction of ponds, impoundments, roads, and ditches) may have had the greatest effect on the Fish Slough ecosystem because they modified the hydrological conditions that historically occurred in Fish Slough. In the central portion of the slough, Fish Slough Lake appears to have expanded in size between 1944 and 1981. This increase may be due to natural geologic subsidence, the construction of Red Willow Dam, or the construction of water impoundments by beavers. The increase in aquatic habitat has likely resulted in the loss of alkaline habitat for Astragalus lentiginosus var. piscinensis as soils near the lake are now saturated for greater portions of the year (Ferren 1991c). Some earthquake events in Chalfant Valley appear to have resulted in decreases in spring discharge or changes in local water table levels (Brian Tillemans, LADWP, pers. comm. 2000), thereby making it more difficult to clearly understand the nature of the local aquifer. Modifications to the slough environment from changes in the local hydrology are not well understood or easily reversed. These factors, in combination with essential data gaps that include, but are not limited to, a more thorough understanding of the ecology and habitat requirements of the species, have made it difficult for local land managers to understand and reverse the decline in the number of A. l. var. piscinensis within the ACEC over he past decade. A downward trend in the species' abundance during the past decade suggests that, despite the ongoing efforts by the relevant land management agencies, additional factors need to be addressed to reverse the decline in the status of A. l. var. piscinensis. We believe that the designated critical habitat unit may require special management considerations to maintain the identified primary constituent elements. These include the potential need to respond to the following: (1) Activities that have the potential to change the hydrology of Fish Slough and adversely affect the survivorship, seed germination, growth, or photosynthesis of Astragalus lentiginosus var. piscinensis, unless such activities are designed and have the effect of recreating the historic environmental conditions that existed in Fish Slough; (2) Activities that have the potential to adversely affect the suitability of alkaline areas that could provide habitat for Astragalus lentiginosus var. piscinensis including, but not limited to, OHV use, levels of cattle grazing that could result in increased soil compaction, road construction and maintenance activities, and water diversion activities; (3) Activities that have the potential to modify the species composition, character, or persistence of the native plant associations that are associated with Astragalus lentiginosus var. piscinensis; (4) Activities that could adversely affect the insect pollinators that inhabit the native upland desert scrub community that is adjacent to alkaline habitats in Fish Slough, including, but not limited to, livestock grazing at levels that would increase soil compaction, use of heavy-wheeled vehicles or OHVs (including motorcycles and all terrain vehicles), pesticide use, and incompatible recreational activities; and (5) Management activities, particularly those that involve cattle grazing and road maintenance, which have the potential to introduce new nonnative plant species that may compete with or displace Astragalus lentiginosus var. piscinensis.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 1998). Astragalus lentiginosus var. piscinensis cannot self-pollinate; therefore, seed production is dependent on cross-pollination (Mazer and Travers 1992).

**Lifespan**

Adult: 15 to 35 years; median of 10 years (USFWS, 2009)

**Dependency on Other Individuals or Species**

Adult: the most likely pollinators (based on records of pollinators on other Astragalus) include bumble bees, leafcutting and mason bees (Megachilidae: Anthidium spp., Hoplitis spp., Osmia spp., Megachile spp.), non-corbiculate (no pollen basket on hind tibia) Apidae (Anthophorinae, Eucerini: Melissodes spp., Synhalonia spp., and Anthophorini: (Anthophora spp., Habropoda spp.), and Andrenidae (Thorp in litt. 2004). (USFWS, 2009)

**Breeding Season**

Adult: Late spring (USFWS, 2009)

**Reproduction Narrative**

Adult: Astragalus lentiginosus var. piscinensis cannot self-pollinate; therefore, seed production is dependent on cross-pollination (Mazer and Travers 1992). Although specific pollinators of A. lentiginosus var piscinensis have not been studied, the most likely pollinators (based on records of pollinators on other Astragalus) include bumble bees, leafcutting and mason bees (Megachilidae: Anthidium spp., Hoplitis spp., Osmia spp., Megachile spp.), non-corbiculate (no pollen basket on hind tibia) Apidae (Anthophorinae, Eucerini: Melissodes spp., Synhalonia spp., and Anthophorini: (Anthophora spp., Habropoda spp.), and Andrenidae (Thorp in litt. 2004). Astragalus lentiginosus var. piscinensis is an herbaceous perennial that produces relatively few seeds with narrow germination requirements and low probability of dispersal. Seed scarification is essential for seed germination. The potential life span is estimated at 15 to 35 years, but median life span appears to be about 10 years. (USFWS, 2009) Fish Slough milk-vetch may grow as much as 30 cm (12 in.) per month during its growing season, which lasts from May to September. Flowering usually begins in late spring and bumblebees (Bombus sp.) are the only flower visitors that have been identified. Fruit is typically set in June and July. Pollinator exclusion experiments demonstrated that Fish Slough milk-vetch is not self-fertilizing. Reproductive output is correlated with plant size and differs between colonies in the north and middle areas o fFish Slough. Grazing of flowering and fruiting branches by jackrabbit (Lepus californicus) and rodents reduced reproductive output during the study period (Mazer and Travers 1992).

**Habitat Type**

Adult: Terrestrial and palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Alkali flats (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: The establishment, survival, and growth of juvenile Fish Slough milkvetch plants are strongly influenced by hydrologic conditions at specific sites (Service 2009). Water table level is of ecological importance to Fish Slough milkvetch. Under experimental conditions, this taxon's physiological performance, growth, and fecundity (seed mass, seed production per plant) are limited by hydric soils in excess of approximately 40 percent water content per volume. The taxon's net photosynthetic rates, growth rates, and seed mass were highest in areas of slough habitat where early season (May-June) water table depths exceeded approximately 11.8 in (30 cm) (Murray and Sala 2003). Studies have also indicated that the growth and survival of Fish Slough milkvetch in relatively nitrogen-limited alkali flat habitats are related to the acquisition of biologically fixed nitrogen (root symbiotic bacteria).

**Geographic or Habitat Restraints or Barriers**

Adult: Found along borders of a slough but not in lower wetter habitats (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2009; NatureServe, 2015)

**Site Fidelity**

Adult: High (USFWS, 2009)

**Habitat Narrative**

Adult: Ferren (1991) and Odion et al. (1991) characterized Fish Slough soils and plant communities and provided information about the habitat of Fish Slough milk-vetch. This taxon occurs in the alkali flats in Spartina-Sporobolus plant associations and in the transition zone between Spartina-Sporobolus and Distichlis-Chrysothamnus plant associations described by Odion et al. (1991). It is frequently found with alkali ivesia (Ivesia kingui var. kingui) but rarely in wetter alkali habitats (USFWS 1998).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: The seeds have narrow germination requirements and low probability of dispersal. (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

results suggest an increase in populations, however it is unclear how survey effort may be affecting census numbers (USFWS 2018).

**Resiliency:**

Low (inferred from USFWS, 2009)

**Representation:**

Low (inferred from USFWS, 2009)

**Redundancy:**

Low (inferred from USFWS, 2009)

**Number of Populations:**

7 (USFWS 2009)

**Population Size:**

9,131 individuals (USFWS 2018)

**Additional Population-level Information:**

Harrison et al 2019 found that the three regions are genetically distinct. The range of Astragalus lentiginosus var. piscinensis within Fish Slough is divided into seven zones across three regions. These regions and their zones are as follows: northern region (Zones 6 and 7), middle region (Zones 1 [a and b] and 5), and southern region (Zones 2, 3, and 4). Plants in the northern region of Fish Slough are entirely on Los Angeles Department of Water and Power (LADWP) lands, while those in the middle and southern regions are on lands managed by both LADWP and BLM (See Figure 1.) Censuses of the populations have occurred in 1992, 2000, 2008, and 2016. Results of these surveys are provided in Table 1. Data for 2008 and earlier is the same as presented in the 2009 5-year review. Census methods have combined data for adult and juvenile plants and early census efforts did not collect seedling data. (USFWS, 2022)

**Population Narrative:**

The first comprehensive assessment of the abundance and distribution of Astragalus lentiginosus var. piscinensis was conducted in 1992. At that time, zones (also called colonies) were identified to delineate occupied and/or suitable habitat There are seven zones within three regions located across the range of Astragalus lentiginosus var. piscinensis. These regions and their zones are as follows: Northern Region (Zones 6 and 7), Middle Region (Zones 1 (a and b) and 5), and Southern Region (Zones 2, 3, and 4). Plants in the northern region of Fish Slough are entirely on LADWP lands while those in the middle and southern regions are on lands managed by both LADWP and BLM. The Northern Region contains the largest percentage of the Astragalus lentiginosus var. piscinensis population whereas the Southern Region has the lowest. Similar surveys were conducted in 2000, 2008, and 2016, which identified seven colonies grouped in three regions. Results of these surveys are provided in Table X. Table X. Number of adult and juvenile Astragalus lentiginosus var. piscinensis counted during each census (modified from Service 2018). Year Region Total Number of Plants (Adults and juveniles) Northern Middle Southern 1992 1,993 1,076 94 3,163 2000 717 747 79 1,543 2008 3,299 1,063 131 4,493 2016* 6,274 2,783 74 9,131 *The survey conducted in 2016 was not a true census since the survey did not cover the entire range of the species. The fewest plants were observed in 2000 and the most were observed in 2016. There is little to no information from the previous censuses to compare how survey effort may have varied over time (Service 2018). Survey effort affects ability to accurately compare population counts across years.

***Threats and Stressors***

**Stressor:** Grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the listing rule we noted that grazing that began in the 1860s was ongoing on all LADWP lands except in the northern 80 ac (32 ha) exclosure (63 FR 53608). Over time, trampling by livestock has the potential to alters the composition of the plant community by reducing or eliminating those that cannot tolerate trampling and increasing those species that tolerate disturbance. This may also introduce taxa that were not previously part of the native plant community. (USFWS, 2009)

**Stressor:** Alteration of habitat- hydrology and non-native plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Past modifications to Fish Slough hydrology include creation of dams and weirs in the main channel of Fish Slough, construction of a dirt road through milkvetch habitat, and soil compaction and trail creation by cattle. These activities have altered hydrology by causing an increase in permanently flooded habitats, artificial ponding, alteration in drainage patterns, and changes in seasonal flooding of milkvetch habitat (Service 1998a). Recovery actions for Owens pupfish that elevate groundwater levels also reduce habitat suitability for Fish Slough milkvetch. Ferren and Davis (1991b) summarized impacts to botanical resources at Fish Slough, noting that those related to the enhancement of fisheries (construction of ponds, impoundments, roads, and ditches) have resulted in the greatest losses to the milkvetch's specific alkali habitats. IN addition, impacts to groundwater that affect spring flow feeding spring springs around Fish Slough and thus the Slough itself (such as those discussed in Zdon et al. 2020) may result in changes to hydrologic conditions needed by the species. Undesirable plant species may be introduced and flourish under disturbance caused by grazing or other sources. Their presence may reduce or eliminate Fish Slough milkvetch through competition for resources (Service 1998a, 2009). Undesirable plant species such as perennial pepperweed are a threat to Fish Slough milkvetch (USFWS, 2009).

**Stressor:** Herbivory (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Herbivory remains a threat to Astragalus lentiginosus var. piscinensis. Seedling herbivory remains a threat to recruitment of new individuals. Field observations suggest that several factors (herbivory, seed germination requirements, seedling establishment, and interspecific competition) interact, placing constraints on Astragalus lentiginosus var. piscinensis survival (Murray and Sala 2003). Infestations of vegetative parts and root systems by phloem-sucking insects and red ants, respectively, and high rabbit herbivory were all reported for individuals of Astragalus lentiginosus var. piscinensis in the middle region of Fish Slough by Mazer and Travers (1992). (USFWS, 2009)

**Stressor:** Lack of recruitment (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, the Service noted that lack of recruitment was a potential threat to Astragalus lentiginosus var. piscinensis. Potential causes cited in the rule were high rabbit/rodent herbivory of seedlings (discussed in Factor C) and changes in soil hydrology or chemistry that make the area less hospitable for seedlings (63 FR 53608). We also discussed the threat of livestock grazing under Factor E of the rule. However, Factor A (which would include alteration in habitat due to cattle grazing) and Factor C (which would include grazing of individual Astragalus plants) are more appropriate. Data on numbers of individuals of A. lentiginosus var. piscinensis, collected from plots in cattle-grazed or trampled and ungrazed areas of Fish Slough from 1991 to 1996, suggest that some recruitment was occurring in both the grazed and ungrazed sample areas. Because the alkali meadow habitat that A. lentiginosus var. piscinensis occupies is likewise moist, cattle may facilitate the establishment of new individuals. (USFWS, 2009)

**Stressor:** Seismic activity (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fish Sough was created recently by geologic events. Although not mentioned in the listing rule, seismic activity leading to changes in hydrology have and will likely continue to have significant effects on the distribution and extent of water availability in Fish Slough and will influence the distribution and viability of Astragalus lentiginosus var. piscinensis habitat (Halford in litt. 2007). (USFWS, 2009) Seismic instability at the Northeast Spring area of Fish Slough was demonstrated in 1986 when an earthquake occurred and changed spring seep patterns.(USFWS, 2009)

**Stressor:** Small population size (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Astragalus lentiginosus var. piscinensis may be vulnerable to extirpation by stochastic factors including demographic stochasticity, environmental stochasticity, and genetic stochasticity (Shaffer 1981). Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of A. lentiginosus var. piscinensis. Environmental stochasticity is the variation in birth and death rates from one season to the next in response to weather,

disease, competition, predation, or other factors external to the population (Shaffer 1981), and this could also play a role in extirpations of small populations. Genetic stochasticity results from the changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The naturally disjunct distribution of A. lentiginosus var. piscinensis decreases genetic variation within the population, which could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). Small population size makes it difficult for A. lentiginosus var. piscinensis to persist while sustaining the impacts of high seedling herbivory rates and changes in soil hydrology or chemistry that make the area less hospitable for seedlings; while impacts from cattle grazing have been reduced, they still remain a concern, exacerbating concerns about the risks associated with small population size. (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change was not discussed at the time of listing. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Astragalus lentiginosus var. piscinensis; small ranged species, such as Astragalus lentiginosus var. piscinensis, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

**Stressor:** Roads and off highway vehicles
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The use of motorized off-road vehicles and the presence of roads have affected habitat occupied by Astragalus lentiginosus var. piscinensis. Approximately 19 mi (30.6 km) of roads exist within 3,280 ft (1,000 m) of the alkaline habitats within Fish Slough. South of BLM Spring, on the east side of the slough, a road bisects one cluster of the listed plants, and off-road vehicle use in the central portion of the slough has been documented (Novak 1992). Soil compaction and topographic changes resulting from road presence and off-road vehicle activity can affect soil moisture regimes in Fish Slough, and potentially result in changes in seasonal inundation patterns that may adversely affect A. l. var. piscinensis. Roads through upland areas in Fish Slough also create increased levels of human visitation that would otherwise be unlikely if roads were absent. Roads have been associated with negative impacts that alter the biotic integrity of both terrestrial and aquatic habitats (Trombulak and Frissell 2000). A growing body of published literature indicates that vehicular traffic along road networks in terrestrial habitats

increases the likelihood that non-native plant seeds will be introduced into areas where they were previously absent (Wace 1977; Schmidt 1989; Lonsdale and Lane 1994). Some of the non-native plant species in Fish Slough (e.g., five hook bassia (Bassia hyssopifolia)) are identified as pest plants of ecological concern (CalEPPC 1999) and have the potential to invade and degrade the quality of alkaline habitats and compete with Astragalus lentiginosus var. piscinensis.

**Stressor:** Pesticides
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pesticides have the ability to directly affect the species and its pollinators.

**Stressor:** Groundwater Conditions (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There have been documented declines in spring flows that support Fish Slough and its vegetation communities since the 1920s, which may be related to increased groundwater pumping in the neighboring valleys referred to as the Tri-Valley area (Service 2005, CDFW 2020, Owens Valley Groundwater Authority [OVGA] 2021). The Tri-Valley area includes the Benton Valley approximately 20 miles (32 kilometers) north, Hammil Valley 9 miles (14 kilometers) north, and the Chalfant Valley approximately 2 miles (3 kilometers) to the northeast of Fish Slough. These three valleys in addition to Fish Slough make up the service area of the Tri-Valley Groundwater Management District. In California, groundwater withdrawal must be managed and monitored in those basins that have been adjudicated or are required to develop and implement a Groundwater Sustainability Plan (GSP) under the Sustainable Groundwater Management Act (SGMA; SB 1168, SB 1319, and AB 1739, effective January 1, 2015). The Tri-Valley area is the northernmost extension of the Owens Valley groundwater basin and Fish Slough is identified as a subbasin (California Department of Water Resources 1975). Because the aquifer in the Tri-Valley area has not been adjudicated and is part of a basin that has been classified as low-priority under SGMA, groundwater withdrawals in this basin are not currently subject to limits pursuant to a court decree or GSP. (USFWS, 2022)

**Stressor:** Genetic stochasticity (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In our 2009 5-year review, we stated that because of its small population size, Fish Slough milkvetch is vulnerable to genetic stochasticity. Lack of genetic diversity impairs the species' ability to adapt to changes in its environment and contributes to inbreeding depression (i.e., loss of reproductive fitness and vigor). However, Harrison et al. 2019 completed genetic analyses on A. lentiginosus. var. piscinensis and found that the three regions of Fish Slough (northern, middle, and southern) came out as three genetically distinct groups, despite being spatially proximate (less than 1 kilometer between regions). Harrison et al. (2019) hypothesized that the genetic grouping is due to habitat-associated local adaptation, specifically due to differences in soil composition across Fish Slough. They recommended that genetic structure be considered for any outplanting efforts and greenhouse studies be conducted to better understand species' responses to various soil conditions. In addition, Harrison et al. (2019) found

low levels of inbreeding and suggested this may be due to larger effective populations sizes than other A. lentiginosus varieties. They also noted that Mazer and Travers (1992) thought that A. lentiginosus rarely self -pollinates and that insect pollination would likely facilitate increased genetic variation. All that being said, the spatial extent of the species remains small and thus stochastic events that decrease population size could result in genetic bottleneck effects in the future. (USFWS, 2022)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 9

**Delisting Criteria:**
1. The Fish Slough vegetation communities [specifically for Astragalus lentiginosus var. piscinensis] are restored and are being managed to maintain conditions such as those described in the Natural Resources Conservation Service (NRCS) Ecological Site Descriptions, the Bureau of Land Management’s (BLM) Desired Plant Community Definitions for springs and wet meadows, and the guidelines for riparian zone proper functioning condition. (USFWS, 2009)

2. Colonies in the north, middle and south regions of the slough are secured from the negative effects of invasive nonnative species, livestock grazing and other human induced threats. (USFWS, 2009)

3. Recruitment of new individuals into the populations and other demographic factors appear sufficient to ensure viability over time as determined by monitoring over a 10 to 15-year period. (USFWS, 2009)

4. Unless research and monitoring show otherwise, population targets for juvenile and adult plants should be a minimum of 2,100 plants in the northern region of Fish Slough, 1,200 in the middle region of Fish Slough and 105 plants in the southern region of Fish Slough; these targets assume that habitat restoration will increase carrying capacity beyond the 1992 levels. (USFWS, 2009)

**Recovery Actions:**
- Needed recovery actions include protection of spring discharges, modification of livestock grazing to ensure that its habitat is not being degraded, restoration of previously suitable habitat that no longer supports the milk-vetch, removal and control of nonnative species and other threats that may arise, protection of lands on which the milk-vetch occurs through a conservation easement or other permanent mechanism, and research to determine its critical life history and habitat components and how these are affected by management actions. Continued monitoring will also be needed. (USFWS, 1998)
- CDFG, BLM and LADWP should work to lower water levels by regulating flow in Fish Slough Lake and monitor Astragalus lentiginosus var. piscinensis recruitment results. (USFWS, 2009)
- BLM should study the benefits of soil disturbances on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)

- BLM should continue with propagation and out-planting projects to enhance recruitment. (USFWS, 2009)
- BLM should study the extent and population impacts of herbivory and ant colony infestations on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- The Service should work with LADWP to develop and implement a grazing plan for LADWP cattle allotment lands within the Fish Slough ACEC. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- • Conduct annual monitoring of A. lentiginosus var. piscinensis. If negative effects from activities are detected, take corrective action. • Ensure grazing leasees operating in areas with A. lentiginosus var. piscinensis are aware of this federally-listed species and measures that can help to minimize impacts from grazing such as adjusting season of use, stocking rates, and careful placement of supplements • Implement appropriate rest/rotation grazing to allow for seed maturity and seed set and to reduce trampling of plants. • Conduct a robust analysis of the impacts of grazing on A. lentiginosus var. piscinensis ; report outcome of analysis to partners. • If using herbicides in A. lentiginosus var. piscinensis occupied habitat, implement measures to avoid chemical contact with this species. These measures include using licensed applicators; follow all label directions, warnings, and precautions to avoid surface runoff and drift; using backpack sprayers or wicking applicators (rather than broadcast spraying); avoiding spraying in/near known locations of milkvetch plants to avoid direct spray and drift; and conducting spot treatments of weeds to confine the area sprayed to the smallest possible area to avoid A. lentiginosus plants and their pollinators.
- Fish Slough Area of Critical Environmental Concern has been established that includes much of the species habitat.
- CDFG, BLM and LADWP should work to lower water levels by regulating flow in Fish Slough Lake and monitor Astragalus lentiginosus var. piscinensis recruitment results. (USFWS, 2009)
- BLM should study the benefits of soil disturbances on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- BLM should continue with propagation and out-planting projects to enhance recruitment. (USFWS, 2009)
- BLM should study the extent and population impacts of herbivory and ant colony infestations on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- The Service should work with LADWP to develop and implement a grazing plan for LADWP cattle allotment lands within the Fish Slough ACEC. (USFWS, 2009)
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Improve the monitoring approach to be able to assess population trend and recruitment rates and to document progress toward meeting other recovery criteria, including restoration and maintenance of the vegetation community, achieving proper functioning condition of springs and riparian areas, and documenting/reducing threats such as invasive species, grazing, and groundwater pumping. 2. The RFWO and recovery partners may consider the need to re-evaluate the recovery criteria for population goals as outlined in the Recovery Plan (Service 1998) based on any modifications to the monitoring approach and best available science. Developing recovery benchmarks based on current threats to the species, the three R’s (resiliency, redundancy, and representation), and the best available science will accurately represent recovery (Smith et al. 2018, entire). 3. Continue investigations of surface and groundwater patterns and structure within and around Fish Slough to understand future impacts on Fish Slough and Fish Slough milkvetch from groundwater pumping and climate change. 4. Continue implementation of recovery tasks as outlined in the 1998 recovery plan and 2009 5-year review (Service 1998b, 2009). (USFWS, 2022)

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# SPECIES ACCOUNT: *Astragalus phoenix* (Ash meadows milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 5/20/1985; Pacific Southwest Region (R8) (USFWS, 2015)

**Physical Description**

A low, mat-forming perennial herb; mats up to 5 dm in diameter. Purple flowers are borne on tiny erect stems from April to early May (NatureServe, 2015).

**Taxonomy**

A member of the Fabaceae (pea family) (USFWS, 2009).

**Historical Range**

This species is endemic to the Ash Meadows area of Nye County, Nevada (USFWS, 2009).

**Current Range**

Occurs in a 7 x 3 mile area in Ash Meadows, Nye Co., Nevada (NatureServe, 2015). The range of the species encompasses the Ash Meadows National Wildlife Refuge and adjacent Bureau of Land Management and private lands (USFWS, 2009).

**Critical Habitat Designated**

Yes; 5/20/1985.

**Legal Description**

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus phoenix (Ash meadows milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

**Critical Habitat Designation**

The critical habitat designation for Astragalus phoenix includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus phoenix critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include dry, hard, white, barren, saline, clay flats, knolls, and slopes.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Self-fertilization (USFWS, 2009)

**Lifespan**

Adult: Unknown, presumed > 10 years (USFWS, 2009)

**Dependency on Other Individuals or Species**

Adult: Probably Anthophora porterae (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Winter and early spring rains (USFWS, 2009)

**Reproduction Narrative**

Adult: Flowers are present from April to early May (Reveal 1979, pp. 2 - 4 and 14 - 15). The biology and life history of the Ash Meadows milkvetch are consistent with a stress-tolerant life history as described by Grime (1977, pp. 1175 - 1181; 1984, pp. 29 - 33). Stress-tolerant plants are typically relatively long-lived with low annual seed production, except during favorable conditions (Grime 1977, pp. 1174 and 1180). Reveal notes winter and early spring rains are required to produce large numbers of flowers, but some flowering probably occurs each year regardless of conditions. During a year with above average precipitation, seed production was estimated to be between 45 and 246 fully formed seeds per average size plant. An examination of the seed to ovule ratio in mature fruits suggested that the ash Meadows milkvetch is an inbreeding species with no pollinator limitations (Pavlik et al. 2006, p. 29). More recent studies indicate that it is visited by a bee (Anthophora porterae) that is likely a vital pollinator for the species (Bio-West 2009, pg 3). Germination events and seedlings are rare (Reveal 1978, p. 12). The lifespan of individual pants is not known, but is believed to exceed 10 years (USFWS, 2009).

**Habitat Type**

Adult: Terrestrial, wetland, spring (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Desert wetland (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 2,200 - 2,300 ft. elevation (USFWS, 2009)

**Environmental Specificity**

Adult: Very narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: High (inferred from USFWS, 2009; see reproduction narrative)

**Habitat Narrative**

Adult: Occurs on dry, hard, white, barren flats, washes, and knolls of calcarious alkaline soils at Ash Meadows - a desert wetland ecosystem maintained by several dozen springs and seeps (NatureServe, 2015). Given the presence of salt crusts and occurrence of halophytes, it is likely that Ash Meadows milkvetch has adaptations that allow it to tolerate saline soils. It grows between 2,200 and 2,300 feet above sea level. Surface and/or subsurface groundwater that reaches the surface through capillary action may be an important habitat determinant for at least some populations (USFWS, 2009).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: Wind and water appear to be the primary vectors for dispersal (Reveal 1978, p. 12). Reveal (1978, p. 14) observed much of the seed produced probably does not disperse long distances and remains within the leaves and branches of the parent plant (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Improving (USFWS, 2009)

**Number of Populations:**

12 (USFWS, 2020)

**Population Size:**

~15,606 (USFWS, 2020)

**Population Narrative:**

At the time of listing, it was estimated that there were 1,000 Ash Meadows milk-vetch individuals (Reveal 1978). In 2001, the Ash Meadows milk-vetch population was estimated to be approximately 1,943 individuals (Morefield 2001). Results from the 2008–2010 Refuge-wide rare plant survey estimate that 15,606 individuals are present on the Refuge (Table 1; BIOWEST 2011). Distribution of Ash Meadows milk-vetch is provided in Figure 1. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Groundwater pumping (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species depends, in part, on near-surface water for its survival. Although the Service has established water rights to 96% of the spring discharge within the Refuge, the Service will have to demonstrate through analyses that the net impact of any change applications will have a negative effect on Ash Meadows. To the extent that the Service is unsuccessful in demonstrating net negative impacts in at least some of these cases, additional incremental declines in spring discharge may occur at Ash Meadows. Such incremental declines could be difficult to attribute to any particular cause after the fact and, therefore, would be difficult to remedy (USFWS, 2009).

**Stressor:** Surface mining (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The playa sediments covering much of the ash Meadows area contain clays and other minerals, which may be considered "uncommon varieties", and therefore could potentially be classified as "locatable minerals" under existing mining laws. New mineral claims and subsequent mining could cause direct loss of Ash Meadows milkvetch habitat, as well as indirect impacts by diverting or draining water away from occupied habitat. About 80% of the known occurrences of Ash Meadows milkvetch within the Refuge are open to mineral entry (USFWS, 2009).

**Stressor:** Nonnative species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Over 100 nonnative species occur on the Refuge. Of these, salt cedar, Russian knapweed, five hook bassia, Malta star thistle, yellow star thistle, and hoary cress are noxious weeds that could potentially threaten the Ash Meadows milkvetch (Service 2006, p. 8). Cheatgrass, red brome, Mediterranean grass, and annual fescue are annual grasses that could potentially threaten the Ash Meadows milkvetch (USFWS, 2009).

**Stressor:** Rabbit herbivory (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** During a demographic study initiated in the spring of 2005, Pavlik et al. (2006, p. 9) found that a very high proportion of developing fruits had been clipped off at the pedicel and eaten by rabbits. They found an 80% loss of potential reproductive output across all subpopulations. Herbivory poses no short-term threat to Ash Meadows milkvetch because individual plants are long-lived, but the significance of any threat posed by rabbits to its persistence over the foreseeable future is poorly understood (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
1. All non-native animals and plant species must be eradicated for essential habitat. These non-native species currently include sailfin mollies, mosquito fish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive (USFWS, 2009).

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 2009).

3. Reestablish water to historic springbrook channels, which are free of barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic range (USFWS, 2009).

4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 2009).

Recovery Priority Number: 8

**Delisting Criteria:**
1. Criteria shown above for downlisting from endangered to threatened (USFWS, 2009).

2. Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 2009).

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats (USFWS, 2009).

4. All of the listed plant species and the candidate plant species are present in all the sites that they have historically occupied as identified in Appendix A Table XV of the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater that the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population (USFWS, 2009).

**Recovery Actions:**
- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new & existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).
- Over the next five years, the Service should focus on clarifying or resolving the uncertainties regarding the significance of the remaining threats to Ash Meadows milkvetch, i.e., groundwater pumping, surface mining, and herbivory (USFWS, 2009).
- The Service anticipates that major issues with respect to the significance of the threat posed by groundwater pumping will become clear over the next five years. Specifically, we expect that the Nevada State Engineer will clarify how Order 1197 will be implemented. In addition, environmental analyses will likely be completed on the anticipated effects of at least some of the proposed solar energy projects, and these should include detailed assessments of the potential effects of any groundwater development requirements on the regional and local aquifers, including potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these analyses to ensure that they adequately disclose all potential impacts that could affect Ash Meadows milkvetch. The Service will also continue its participation in interagency monitoring, modeling, and assessment of the Death Valley Groundwater Flow System (USFWS, 2009).
- The Service and BLM should continue to work toward the completion of the land and mineral withdrawals for public lands within the Refuge and the ACEC. This will likely require that once the withdrawal packages have been forwarded by BLM's Nevada State Director to BLM's Washington Office, that briefings be scheduled with the Service's Washington Office to ensure that the importance of this withdrawal to all of the listed spies at Ash Meadows, as well as the ash Meadows ecosystem, is recognized (USFWS, 2009).

- Research on the potential significance of the rabbit herbivory on the long-term viability of Ash Meadows milkvetch should be prioritized, especially research focused on whether a sufficient seed bank is present to support recruitment when the proper environmental conditions occur. This research should also address potential management options to mitigate the impacts of herbivory on Ash Meadows milkvetch. Additional research is also needed on the sensitivity of the species to hydrological alterations and, in particular, its dependency on soil moisture drawn by capillary action from the near surface groundwater table. Finally, research is needed on the role of hydrologic process in seed dispersal and the extent to which past surface modifications have disrupted this process and the degree to which that affects the viability of current populations (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Over the next five years, the Service should focus on: • Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). • Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); • Support Ash Meadows milk-vetch research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); • Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. • Continue to research and implement a jackrabbit exclusion study to determine the impacts jackrabbits are having on reproduction of Ash Meadows milk-vetch. (USFWS, 2020)

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# SPECIES ACCOUNT: *Astragalus pycnostachyus var. lanosissimus* (Ventura Marsh Milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/21/2001; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

Astragalus pycnostachyus var. lanosissimus is a short-lived herbaceous perennial. It has a thick taproot and multiple erect, reddish stems, 40 to 90 centimeters (cm) (16 to 36 inches (in)) tall that emerge from the root crown. The pinnately compound leaves are densely covered with silvery-white hairs with 27 to 39 leaflets that are 5 to 20 millimeters (mm) (0.2 to 0.8 in) long. The numerous yellowish-white to cream colored flowers are in dense clusters and are 7 to 10 mm (0.3 to 0.4 in) long with 2 to 4 cm (0.8 to 1.6 in) peduncles (Spellenberg 1993). The calyx tube is 3 to 4 mm (0.12 to 0.16 in) long with 1.2- to 1.5-mm (0.04-in) long calyx teeth (Spellenberg 1993). The nearly sessile, single-celled pod is 8 to 11 mm (0.31 to 0.43 in) long (Barneby 1964) (USFWS, 2010).

**Taxonomy**

Member of the Fabaceae (pea family) (USFWS, 2010).

**Historical Range**

Historically, Ventura to Orange County, California; along the coast in salt marshes (NatureServe, 2015).

**Current Range**

Currently known from one naturally-occurring site in Ventura County (U.S. Fish and Wildlife Service 2001). There are also four introduction sites, two in Ventura County and two in Santa Barbara County (which is outside the historic range of this taxon) (M. Meyer pers. comm. 2010) (NatureServe, 2015).

**Critical Habitat Designated**

Yes; 5/20/2004.

**Legal Description**

On May 20, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus pycnostachyus var. lanosissimus (Ventura Marsh Milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (69 FR 29081-29100).

**Critical Habitat Designation**

The critical habitat designation for Astragalus pycnostachyus var. lanosissimus includes three CHUs in Santa Barbara and Ventura Counties, California. This species critical habitat encompasses approximately 420 acres (ac) (170 hectares (ha)) (69 FR 29081-29100).

Mandalay Unit: The Mandalay Unit is approximately 153 ac (62 ha) in size and is essential to the conservation of Astragalus pycnostachyus var. lanosissimus because it contains the only known location where Astragalus pycnostachyus var. lanosissimus naturally exists and the remainder of the unit also supports the primary constituent elements. The State-owned Mandalay State Beach is managed by the Ventura County Parks and Recreation Department and comprises about 49 ac (20 ha) of this unit. The remaining area of the unit is privately owned and is currently undeveloped, but has been chosen as the site for a 300-housing-unit subdivision (Economic and Planning Systems, Inc. 2003). The pending development is called North Shore at Mandalay and would occur in the eastern portion of this critical habitat unit. The project includes a 1.65-ac (0.67-ha) ''milk-vetch preservation area'' encompassing the entire natural population (California Coastal Commission 2002), which in turn, would be inside a 23.8-ac (9.6-ha) resource protection area (RPA). The RPA would be buffered from adjacent residential development by a 50-ft (15 m) wide landscaped area. The population will be mostly isolated from surrounding vegetation, and the ecological processes sustaining the population may be interrupted. Also, the project may allow increased human intrusion, provide habitat for nonnative plants and snails, alter the hydrologic regime, and introduce pesticides and fertilizers that adversely affect the plants. Therefore, the risk of extinction of the subspecies is high without the development of additional populations. The portion of this unit on Mandalay State Beach is identified by Wilken and Wardlaw (2001) as a possible site for establishing a new population of Astragalus pycnostachyus var. lanosissimus. In 2003, the first efforts at researching how new populations could be established in this unit were begun. The proximity of Mandalay State Beach to the extant population indicates that some natural exchange of seeds or pollen could take place if a second population were established at Mandalay State Beach. The site contains one or more of the primary constituent elements defined for Astragalus pycnostachyus var. lanosissimus critical habitat, although Wilken and Wardlaw (2001) note some dense cover of nonnative annuals. Also, using their five parameters, Wilken and Wardlaw (2001) ranked the Mandalay State Beach portion of this unit as one of the most similar to the natural occurrences of Astragalus pycnostachyus var. lanosissimus and the closely related Astragalus pycnostachyus var. pycnostachyus, and hence one of the top candidates for establishing a new population. California Department of Parks and Recreation (CDPR) has approved experimental introductions of Astragalus pycnostachyus var. lanosissimus conducted by the CDFG. Because the area is public land owned by the CDPR and the species is Statelisted, we will work with the State to develop conservation strategies to reintroduce the subspecies and develop and manage reserves. As discussed above, this unit is essential for the conservation of Astragalus pycnostachyus var. lanosissimus because it contains the primary constituent elements for Astragalus pycnostachyus var. lanosissimus. The population of Astragalus pycnostachyus var. lanosissimus at the North Shore at Mandalay site is the only naturallyoccurring, self-perpetuating population of the species in existence. It has provided all of the initial propagules for establishing research populations of the species at other sites, and continues to be the source of genetic variability for future propagation. The research populations at McGrath State Beach and Carpinteria Marsh are not intended to become new populations for the recovery of the species, but were established to generate data on the species' needs when such introductions for recovery begin. Their persistence is uncertain, and we have observed some failures (see Background section). Consequently, the population of Astragalus pycnostachyus var. lanosissimus on the North Shore at Mandalay site is currently the only one of which we can be relatively certain that the plants will persist. If this population is extirpated, and the research populations ultimately fail, all of the remaining individuals of Astragalus pycnostachyus var. lanosissimus will exist as seeds in collections or propagated in greenhouses. The designation of the North Shore at Mandalay site as critical habitat recognizes that this population is essential to the species' conservation. This southernmost unit is geographically separated from other critical habitat within its historical range. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

McGrath Unit: The site within McGrath Beach State Park is adjacent to McGrath Lake on the leeward side of the southern end of the lake, between the lake and Harbor Boulevard. The unit covers 62 ac (25 ha). It includes 35 ac (14 ha) of private land and 27 ac (11 ha) of State-owned land managed by CDPR. Of the sites they examined, Wilken and Wardlaw (2001) identify the McGrath Lake area as having the best combination of habitat characteristics similar to that of the extant population of Astragalus pycnostachyus var. lanosissimus and its closest relative, Astragalus pycnostachyus var. pycnostachyus based upon five parameters (i.e., dominant vegetation composed of a shrub canopy less than 75 percent; absence of competitive annual or perennial exotic plants; water table in close proximity; soil types consistent with that at the site of the extant population; and native habitat supporting pollinators). CDPR agreed to allow CDFG and RSABG establish a research population on this site. This effort is still in its early stages, and no conclusive data have yet been retrieved. Because the area is currently operated by CDPR and is public land, there is opportunity to work with the State to develop reintroduction strategies for Astragalus pycnostachyus var. lanosissimus and to form manageable reserves. This unit is also one of the last known places where the subspecies was observed growing naturally, and it is close to the extant population and shares many of the broader climatic and habitat features of that site. As discussed above, this unit is essential for the conservation of Astragalus pycnostachyus var. lanosissimus because it once supported a population Astragalus pycnostachyus var. lanosissimus until it was extirpated in 1967. It contains the primary constituent elements for Astragalus pycnostachyus var. lanosissimus. It includes habitat that is necessary for the expansion of the only known population, which may become nonviable in the future. It contains habitat features that are essential for this species including, but not limited to, high diversity of native plants, open canopy, sandy dune hollows, seep margin areas, subterranean water table. This central unit is geographically separated from other critical habitat within Astragalus pycnostachyus var. lanosissimus historical range. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

Carpinteria Salt Marsh Unit: The Carpinteria Salt Marsh Unit extends from the Southern Pacific Railroad tracks south and west to Sand Point Drive and Santa Monica Creek and is approximately 205 ac (83 ha) in size. The entire unit is managed by the UC, Santa Barbara. This unit includes saltmarsh habitat, which is essential to support the pollinators and other ecological processes that Astragalus pycnostachyus var. lanosissimus requires for its survival. The research population of Astragalus pycnostachyus var. lanosissimus was introduced in April 2002 into a portion of the unit. As of February 2003, 44 percent (68) of the 155 original plants survived. By June 2003, only 20 seedlings had been produced by plants at one of the planting sites. We have determined that this area contains the primary constituent elements necessary for the introduction of Astragalus pycnostachyus var. lanosissimus based on Wilken and Wardlaw's (2001) description of five parameters of habitat suitability. These parameters closely parallel the primary constituent elements, so one or more of the elements are represented at this site. The diverse native vegetation provides for a robust pollinator community. The unit is bordered by a residential community where nonnative snails were observed; protection is required for herbivory by snails on Astragalus pycnostachyus var. lanosissimus plants. This site in Santa Barbara County is near the range of the subspecies as predicted by the historical collections and described by Skinner and Pavlik (1994), who list the known counties as Ventura, Los Angeles, and Orange. We have included this unit because, although it is outside the historical range for Astragalus pycnostachyus var. lanosissimus: (1) Insufficient suitable habitat for the subspecies remains within its historical range; and (2) the area has habitat features essential to the conservation of the subspecies, which suggests a high potential for successful establishment of a new population (Wilken and Wardlaw 2001). This unit is essential for the conservation of Astragalus pycnostachyus var. lanosissimus because it supports the pollinators and other ecological processes for Astragalus pycnostachyus var. lanosissimus. It contains habitat features that are essential for this species including, but not limited to, dominant vegetation composed of a shrub canopy less than 75 percent; absence of competitive annual or perennial exotic plants; water table in close proximity; soil type; and native habitat supporting pollinators. Seedling recruitment has been observed at this site in the research population. This northernmost unit is geographically separated from other critical habitat. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus pycnostachyus var. lanosissimus critical habitat consists of five components (69 FR 29081-29100):

(i) Vegetation cover of at least 50 percent but not exceeding 75 percent, consisting primarily of known associated native species, including but not limited to, Baccharis salicifolia, Baccharis pilularis, Salix lasiolepis, Lotus scoparius, and Ericameria ericoides;

(ii) Low densities of nonnative annual plants and shrubs;

(iii) The presence of a high water table, either fresh or brackish, as evidenced by the presence of channels, sloughs, or depressions that may support stands of Salix lasiolepis, Typha spp., and Scirpus spp.;

(iv) Soils that are fine-grained, composed primarily of sand with some clay and silt, yet are well-drained; and

(v) Soils that do not exhibit a white crystalline crust that would indicate saline or alkaline conditions.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas determined to be essential for the conservation of the species may require special management or protections. The Mandalay Unit may require special management considerations or protections due to the threats to the species and its habitat posed by development (e.g., loss of native vegetation, disruption of pollinator community, herbivory by snails, increase in non-native plants, soil remediation), herbivory by rabbits, and trampling as a result of human activity. Currently, competition by non-native plants, herbivory by snails and rabbits, and human activity are ongoing in the Mandalay Unit. The McGrath Unit may require special management considerations or protections due to the threats to the species and its habitat posed by invasive, non-native plants and trampling as a result of human activity. Currently, competition from non-native plants and human activity are ongoing in the McGrath Unit. The Carpinteria Salt Marsh Unit may require special management considerations or protections due to the threats to the species and its habitat posed by nonnative plants and high salinity. Currently, competition from non-native plants and fluctuations in salinity levels are ongoing in the Carpinteria Salt Marsh Unit.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2010)

**Lifespan**

Adult: 3 - 4 years (USFWS, 2010)

**Breeding Season**

Adult: July - October, one observation in June (USFWS, 2010)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2010); soil seed bank (USFWS, 2004)

**Reproduction Narrative**

Adult: It is believed to have a 3 to 4-year life span (Wilken and Wardlaw 2001). The blooming time has been recorded as July to October (Barneby 1964); however, the population at the site where the plants were rediscovered, referred to as the site of natural occurrence, was observed in flower in June 1997. Wilken and Wardlaw (2001) observed peak flowering of the plants at this site in mid-July with most flowers maturing into fruits by early September. The variety appears to be self-compatible and partly self-pollinating (Wilken and Wardlaw 2001); however, the flower structure of this variety, and other Astragalus species, suggests that pollination requires manipulation of flower parts by insects (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) observed a limited number of skippers (family Hesperidae) and bumblebees (Bombus spp.) visiting the plants. Other researchers have observed various bee and butterfly species frequently visiting A. pycnostachyus var. lanosissimus (Meyer 2007a, Jensen 2007), indicating that insects may be the natural pollinators of this plant. The life cycle of A. pycnostachyus var. lanosissimus likely requires a pollinator community to be present (Greer et al. 1995; Karron 1987). Wilken and Wardlaw (2001) observed an average of 26 inflorescences per plant, with an average of 36 flowers per inflorescence, and between 7 and 9 ovules per ovary (a potential maximum of 7 to 9 seeds per flower). However, the number of seeds per fruit was only approximately 2 on average. This level of productivity is low relative to many other species of Astragalus that are known to be self compatible and therefore would be expected to produce more seed (Karron 1987). Seed production is suspected to be limited by a lack of pollination. This delayed seed germination, combined with the observation that plants may not become reproductive until 18 to 30 months following germination, and a low seedling survival rate (Wilken and Wardlaw 2001), indicates a low recruitment rate for the variety (USFWS, 2010). The population is able to persist due to having established a seedbank (not all seeds produced in one year will germinate the following year) (USFWS, 2004).

**Habitat Type**

Adult: Terrestrial, wetland, aquatic (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Dune, grassland, shrubland, spring, herbaceous wetland (NatureServe, 2015); coastal dune-swales (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: 0 - 30 m elevation (NatureServe, 2015); high competition from other plant species (USFWS, 2010)

**Environmental Specificity**

Adult: Very narrow to narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Historically probably occurred on open sites near the coast on soils with a high water table, such as on bluffs or flats near seeps or bodies of brackish or fresh water, or in or near coastal marshes. Currently, a population occurs on an abandoned oil-field waste site in remnant backdunes. This area has an artificially compact substrate of clay, sand, and small gravel, above a capped oil layer, generally about 45 cm below the soil surface. Occurs from 0 - 30 m elevation. The environmental specificity is very narrow to narrow, although habitat requirements are poorly understood (NatureServe, 2015). Based on existing information from historical collections, Wilken and Wardlaw (2001) concluded that the variety occurs in low elevation coastal dune-swale areas where freshwater levels (in the form of saturated soils or groundwater) are high enough to reach the roots of the plants. The soils associated with Astragalus pycnostachyus var. lanosissimus are well-drained, yet contain a mix of sand and clay. Meyer (2007a) indicated that low competition from native and nonnative species contributes to the success of Astragalus pycnostachyus var. lanosissimus establishment in these areas (USFWS, 2010). Primary constituent elements include vegetation cover of at least 50 percent but not exceeding 75 percent; low densities of nonnative annual plants and shrubs; the presence of a high water table, either fresh or brackish; soils that are fine-grained, composed primarily of sand with some clay and silt, yet are well-drained; and soils that do not exhibit a white crystalline crust that would indicate saline or alkaline conditions (USFWS, 2004).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Decline of 50-90% (NatureServe, 2015); believed extinct until 1997 (USFWS, 2010)

**Species Trends:**

Declining (USFWS, 2010)

**Population Growth Rate:**

Slow (inferred from USFWS, 2004)

**Number of Populations:**

4 (USFWS, 2023)

**Population Size:**

>700 individuals in 4 populations (USFWS, 2023)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

For the only known naturally-occurring population, low population size increases vulnerability to decline/extirpation from stochastic events. This species has experienced a long-term decline of 50-90%. Recent population sizes at the naturally-occurring site include 104 plants (60 flowering) in 2006 and 27 plants (19 flowering) in 2009 (M. Meyer unpublished data 2010). This represents an overall decline corresponding to two low rainfall years and completion (in 2007) of remediation on the surrounding area outside the 1.6 acre exclosure in which plants occur. Collectively, the four introduced sites had 801 plants (283 flowering) in 2009; most of these individuals were at one of the Santa Barbara County sites (M. Meyer unpublished data 2010). Most historical or extirpated; one naturally-occurring site discovered in Ventura County in 1997 (U.S. Fish and Wildlife Service 2001). The presumption is that the original source of seed at this site came from some either onsite or nearby top soil brought in to cap the oil waste facility when it closed in 1982 (M. Meyer pers. comm. 2010). There are also four introduction sites, two in Ventura County and two in Santa Barbara County (which is outside the historic range of this taxon). As yet, it is unclear whether these introductions will persist and become self-sustaining populations (M. Meyer pers. comm. 2010) (NatureServe, 2015). It was believed to be extinct until its rediscovery in 1997. Currently the North Shore site supports only 31 individuals and the habitat at the site has possibly been permanently negatively altered by remediation activities in areas surrounding the plants. Research was conducted to identify potential suitable habitat characteristics and introductions were attempted at several sites within and outside the historic range of the species, including Ormond Beach, Mandalay State Beach, McGrath Beach, Carpinteria Salt Marsh, and Coal Oil Point. Astragalus pycnostachyus var. lanosissimus did not survive at Ormond Beach. Plants currently remain at the other outplanting sites, but have shown a relatively steady decline in abundance since the heavy rains of 2004-2005, and may benefit from another substantially wet season (USFWS, 2010). The single natural population of Astragalus pycnostachyus var. lanosissimus near the city of Oxnard is in a degraded backdune community. Due to the combination of poor seedling and young plant survivorship and low seed production, the single naturally occurring population of Astragalus pycnostachyus var. lanosissimus has continued to decline since its rediscovery in 1997 and through the 2001 season (Impacts Sciences 1997, 1998; Wilken and Wardlaw 2001; Dieter Wilken, Santa Barbara Botanic Garden, pers. comm. 2002) (USFWS, 2004). Ventura marsh milk-vetch (Astragalus pycnostachyus var. lanosissimus) was historically found in Los Angeles and Ventura County coastal wetlands. There is one known naturally occurring population (North Shore), and eight deliberately planted populations, which were all planted from North Shore seed stock. Four of the planted populations are north of the historically known range, justified by available planting locations and anticipated climate change. There are 4 populations of reproductive adults (the rediscovered population and three introduced populations), 2 populations of seed banks in suitable habitat, and 3 populations of seed banks in unsuitable habitat. (USFWS, 2020) The four currently occupied sites are North Shore, McGrath Parcel, North Campus Open Space, and Carpinteria Salt Marsh (Table 1), and occupy four unique ecological, ownership, and management situations. For a new site to be established with the goal of establishing a new population, it would need to be spatially and ecologically distinct from any existing sites (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** much of the habitat that supported historical populations of Astragalus pycnostachyus var. lanosissimus has been altered or destroyed such that it is no longer suitable for the species. Habitat conditions at the North Shore site have been altered by remediation activities, but will be protected by a preserve created as part of the MOU between CDFG and the project proponent (USFWS, 2010).

**Stressor:** Disease and predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The seeds of Astragalus pycnostachyus var. lanosissimus at the site of natural occurrence were heavily infested with seed beetles (Bruchidae: Coleptera) in 1997. In a seed collection made for conservation purposes in 1997, most fruits partially developed at least 4 seeds but seed predation reduced the average number of undamaged seeds to only 1.8 per fruit (Steeck and Meyer, in litt. 1997). The nonnative milk snail (Otala lacteal) was observed causing damage to the foliage of Astragalus pycnostachyus var. lanosissimus in 1998 and 1999 concurrent with a dramatic decline in seedling plants (Meyer 2007a). European brown garden snails (Helix aspera) are frequently observed at the outplanting sites and can potentially defoliate individual plants, damage new growth, and compromise vigor (Jensen 2007; Meyer 2007a). Meyer (2007a) reports that gophers (Thomomys bottae), rabbits (presumably Lepus spp. or Sylvilagus spp.), and meadow voles (Microtus spp.) are common at the milk-vetch outplanting sites and impact plants by removing seedlings and damaging established plants. Sooty fungus continues to be occasionally observed on A. pycnostachyus var. lanosissimus individuals, but does not appear to substantially adversely affect the health or productivity of the plants (USFWS, 2010).

**Stressor:** Stochastic events (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing Astragalus pycnostachyus var. lanosissimus in 2001, the Service discussed that the taxon is threatened with extinction from unanticipated human activities and natural events by virtue of the very limited number of individuals in, and the small area occupied by, the only known extant population. A wildlife predation event in the summer before seeds have matured, a plane crash (the taxon is under the extended center flight line of the Oxnard airport and a crash occurred on the site in 1995), and other natural or unanticipated human-caused events could eliminate the existing population and result in the extirpation of this taxon from the only known remaining site of natural occurrence in the wild.

**Stressor:** Inadequate preserve design (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The small size of the preserve and its proximity to future urban and suburban uses makes it subject to the effects of nonnative, invasive plant and animal species, increased nutrient-rich water supply due to suburban irrigation runoff and increased impervious surfaces, and chemicals such as herbicides, pesticides, and fertilizers (see Conservation Biology Institute 2000, CDFG 2000 and references therein). Independently or in combinations, these factors present difficult management challenges which, if not adequately addressed, could lead to the elimination of A. pycnostachyus var. lanosissimus from the North Shore site. Nonnative plant and animal species are competitors and predators, respectively, that can directly reduce survival of native plants and they can also upset the invertebrate (pollinator) and vascular plant associations upon which native plants depend (Conservation Biology Institute 2000). While the life history requirements of A. pycnostachyus var. lanosissimus are not well understood, any factor that substantially alters the hydrology of the site, such as increases or decreases in urban/suburban runoff, may make the site unsuitable for this wetland species (Conservation Biology Institute 2000). Likewise, increased levels of chemicals arriving via runoff or drift can be expected in small preserves and can harm native species (Conservation Biology Institute 2000). These increases could harm A. pycnostachyus var. lanosissimus directly, or alter the pollinator or plant associations upon which it depends (USFWS, 2010).

**Stressor:** Competition (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative weeds such as iceplant, as well as some native species such as Anemopsis californica (yerba mansa), Potentilla anserina (silverweed) and Distichlis spicata (salt grass) can form dense continuous patches that exclude Astragalus pycnostachyus var. lanosissimus (Meyer 2007a) (USFWS, 2010).

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, and that species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. While the Service lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Astragalus pycnostachyus var. lanosissimus, small-ranged species, such as A. pycnostachyus var. lanosissimus, are generally more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2010).

**Stressor:** Sea level rise (USFWS, 2010)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** An increase in the rate of sea level rise has been predicted for the coast of California (California Climate Change Center 2006). The occurrences of Astragalus pycnostachyus var. lanosissimus at Mandalay State Beach, McGrath Lake, and Carpinteria Salt Marsh Reserve are bounded by residential, industrial, or agricultural areas that would preclude the taxon’s migration inland as sea level rises (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
Ventura marsh milk-vetch may be considered for downlisting when all the following criteria are met: 1. Abundance within each of four sites is an average of 100 or more reproductive individuals per site with a stable or increasing trend based on a minimum of 10 years of data. Funding and resources are available so that if a population drops below 25 reproductive individuals in any single year, supplemental seed or seedlings may be planted, or artificial disturbance applied. 2. The four sites are managed such that the functions of disturbance, colonization, and succession allow for successful Ventura marsh milk-vetch population persistence, including site plant species composition comprised of at least 50% appropriate native species, with native species vegetative cover being greater than non-native species vegetative cover. Details of suitable habitat conditions are described in the SSA (Service 2020, pp. 12-20). 3. Management at the four sites is assured in perpetuity and is shown to be effective by stable or increasing populations based on a minimum of 10 years of data. 4. Ex situ recovery seed banks are established and maintained over time with sufficient seed so that stored seed may be used for recovery efforts while not exhausting the seed supply and decreasing seed bank genetic diversity. At a minimum, seed should be stored within a longterm storage facility such as the National Laboratory for Genetic Resources Preservation in Fort Collins, Colorado, as well as in at least two institutions approved by the Center for Plant Conservation with the capability to test viability and germination as needed. New accessions are added to each institution as new sites are established, and seed is added so that the most recent accession is no more than 15 years old (USFWS, 2023).

Recovery Priority Number: 6C

**Delisting Criteria:**
Once the downlisting criteria have been met, Ventura marsh milk-vetch may be considered for delisting when all the following criteria are met: 1. Two additional sites are established (for a total of six) that have an average abundance of 100 or more reproductive individuals per site with a stable or increasing trend over 10 years of data. Funding and resources are available so that if a population drops below 25 reproductive individuals in any single year, supplemental seed or seedlings may be planted, or artificial disturbance applied. 2. The two additional sites are managed such that the functions of disturbance, colonization, and succession allow for successful Ventura marsh milk-vetch population persistence, including site plant species composition comprised of at least 50% appropriate native species, with native species vegetative cover being greater than non-native species vegetative cover. Details of suitable habitat conditions are described in the SSA (Service 2020, pp. 12-20). 3. Management at the two additional sites is assured in perpetuity and is shown to be effective by stable or increasing populations based on a minimum of 10 years of data (USFWS, 2023).

**Recovery Actions:**

- 1. Manage habitat that supports the species to reduce or eliminate threats, including supplemental seeding, irrigation, vegetation composition and density, and herbivore control. (Priority 1) 2. Conduct annual monitoring to identify population trajectories and environmental conditions that might be adversely affecting the species. (Priority 1) 3. Protect currently unprotected habitat where the taxon occurs or could occur. (Priority 2) 4. Collect seed and deposit accessions into a permanent conservation seed bank. (Priority 2) 5. Conduct experimental research projects, including those that examine the roles of biotic and abiotic environmental effects, natural soil seed banks, and disturbance. (Priority 2) (USFWS, 2023)
- Convene a recovery team and develop a recovery plan for Astragalus pycnostachyus var. lanosissimus (USFWS, 2010).
- Work with CDPR staff to continue iceplant removal and habitat restoration around McGrath Lake to improve and expand available habitat for Astragalus pycnostachyus var. lanosissimus (USFWS, 2010).
- Determine if changes in the upper aquifer at the North Shore site have resulted from remediation activities surrounding the plants, and determine whether a supplemental watering system can compensate for altered water availability, or if additional measures are needed to compensate for negative impacts (USFWS, 2010).
- Build on the work of Meyer, Jensen, Wilken, and others to identify freshwater-dominated coastal wetlands with sufficient surrounding area and proper vegetation (i.e., sufficiently sparse areas, free of dense mats of vegetation) for Astragalus pycnostachyus var. lanosissimus introduction (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Develop a recovery plan for Astragalus pycnostachyus var. lanosissimus. 2. Continue habitat restoration at McGrath Parcel to improve and expand available habitat for Astragalus pycnostachyus var. lanosissimus. 3. Monitor the success of the North Campus Open Space planting site. 4. Enhance the sites with extant seed banks and potential habitat. 5. Build on previous work to identify appropriate fresh-water dominated coastal wetlands of sufficient area and proper conditions (sparsely vegetated, free of mats of perennial vegetation, proper hydrology) for Astragalus pycnostachyus var. lanosissimus introduction. (USFWS, 2020)
- FUTURE SCENARIO 2 (INCREASING MANAGEMENT) Under Future Scenario 2, management activities that benefit Astragalus pycnostachyus var. lanosissimus increase at past and current reintroduction sites. Key management activities that increase the suitability of habitat include non-native and native species management to reduce competition for juvenile and adult individuals of the species, controlling herbivory through exclusion fencing, removing snails, and decreasing shrub and tree vegetation in order to reduce cover for and thus discourage herbivorous mammals. Currently, supplemental planting is used infrequently at introduced sites, only when reproducing adults have not been present for several years and when conditions are believed to be suitable. This is done to both check site suitability at that time and to increase the local seed bank if the supplemental plants successfully produce seed. Supplemental watering is used to establish populations at initial introduction or when supplemental planting occurs. Additional supplemental water is used sparingly to reduce the effects of drought and desiccation from changes in seasonal precipitation. These activities already occur at the North Shore site and the McGrath Parcel and will continue under this scenario. Additional sites for reintroduction are identified and managed under Future Scenario 2.

This includes the North Campus Open Space (NCOS) Restoration Project and the Ormond Beach Restoration and Public Access Project. Restoration activities at the NCOS restoration site are likely to have positive influences on associated species and vegetation cover facilitating the survival of individuals planted in 2019. Those adults will contribute to a growing seedbank as they reach reproductive maturity. The success of this restoration project will provide future opportunity for introducing Astragalus pycnostachyus var. lanosissimus into newly suitable habitat in other areas within the NCOS restoration site. The expansion of natural environments within the broader Devereux Slough ecosystem may also provide some ability for the migration of suitable habitat reducing the negative effects of climate change at this specific location. In this scenario we also expect a new population to be introduced to a unique location at the newly restored Ormond Beach Restoration and Public Access Project (not at the location of the extirpated Ormond Beach site). The Coal Oil Point Reserve pond site, Carpinteria Salt Marsh Reserve, and McGrath State Beach will have increased management resulting in the reestablishment of reproductive adults in these populations. Weed management and supplemental planting are likely to have the greatest effect at these sites. Development surrounding the North Shore site has negative impacts on the North Shore population, but these will be mitigated through continued and/or additional measures as necessary because of the requirement to manage in perpetuity. The North Shore population continues to be conservation reliant in this scenario. The effects of climate change are still significant in this scenario, with decreases in winter precipitation frequency, increases in winter precipitation intensity, and increases in average, maximum, and minimum temperatures. The results increase stress and mortality on existing and potential future Astragalus pycnostachyus var. lanosissimus populations while decreasing the amount of available suitable habitat. The effects are offset only slightly through management activities since they cannot directly address declining water tables and broad shifts in precipitation patterns and temperature. The management under this scenario does improve habitat locally at all sites, as well as potential sites, resulting in a greater ability for migration of vegetation and suitable habitat. (USFWS, 2020a)

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# SPECIES ACCOUNT: *Astragalus robbinsii var. jesupi* (Jesup's milk-vetch)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** JMV

**Listing Status:** Endangered; 7/6/1987; Northeast Region (R5)

**Physical Description**

A short-lived perennial, herbaceous legume that is 10 to 50 centimeters (cm) (4 to 20 inches [in]) tall with a tap root. Jesup’s milk-vetch stems originate from a single root crown and may branch several times. Older plants tend to be more profusely branched than younger plants. Its leaves are pinnately compound, divided into 9 to 15 oblong to elliptical, glabrous leaflets 8 to 20 millimeters (mm) (0.3 to 0.8 in) long. The first true leaves of seedlings are produced in triads and arrayed in a clover-leaf fashion; as plants mature, the number of leaflets per leaf increases. The raceme2 of 8 to 21 small (9 to 12 mm [0.3 to 0.5 in long]), pale bluish-violet, pea-like flowers is borne at the top of the stem. Flowering plants may have from 1 to 120 racemes. The inflorescence is compact initially, but as flowering proceeds, the axis of the raceme continues to elongate somewhat throughout fruit development, especially in more shaded conditions (Farnsworth and Harvey 2004). The fruit is a legume about 1.5 to 2 cm (0.6 to 0.8 in) long, borne on a short stem, narrowed at both ends and terminated with a distinctive beak 1.5 to 3 mm (0.8 to 0.1 in) long. The body of the legume has scattered black, appressed hairs. Inflorescences produce, on average, approximately 56 seeds per inflorescence (8 legumes per inflorescence, 7 seeds per legume), although larger plants produce more legumes and seeds per legumes. (USFWS, 2019)

**Taxonomy**

A member of the legume family (Fabaceae). Jesup’s milk-vetch was first collected in 1877 at Sumner Falls in Plainfield, NH by Professor Henry Griswold Jesup of Dartmouth College. The variety (as “jesupi”) was subsequently described by Eggleston and Sheldon in 1894 in Minnesota Botanical Studies 1: 155, following collection of the specimens (deposited at MINN) by Eggleston on June 7, 1891, on “old ledges above high water of the Connecticut River near Hartland, Vt.... and on ledges near Sumner Falls, near Plainfield, N.H.” (Barneby 1964: 131; Revised Jesup’s Milk-Vetch Recovery Plan 4 w 3Tropicos Database 2019). Recent synonyms for this taxon include Astragalus jesupii (Egglest. & Sheldon) Britt. (published in Britton 1901: 1048) and Atelophragma jesupii (Egglest. & Sheldon) Rydberg published in Bulletin of the Torrey Botanical Club 55: 125 (1928). Although the taxon was federally listed endangered under the variant spelling Astragalus robbinsii var. jesupi, and the first recovery plan recognized the taxon as Astragalus robbinsii var. jesupi, the current nomenclature for the species is Astragalus robbinsii var. jesupii, following the standards outlined in the International Code of Botanical Nomenclature (accessed February 4, 2019). (USFWS, 2019)

**Historical Range**

In Sullivan County, New Hampshire, and Windsor County, Vermont. Known from five distinct sites along a 16-mi sector of the Connecticut River between central New Hampshire and central Vermont. (USFWS, 2019)

**Current Range**

In Sullivan County, New Hampshire, and Windsor County, Vermont. Extant at three distinct sites along a 16-mi sector of the Connecticut River between central New Hampshire and central Vermont. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect and Self-fertilization (USFWS, 2019)

**Lifespan**

Adult: Generally 3 years (USFWS, 2019)

**Breeding Season**

Adult: Flowers in late May or early June; sets seed through August (USFWS, 2019)

**Other Reproductive Information**

Adult: The Jesup's milk-vetch life cycle consists of seed germination and growth to seedling in year one; emerging as a small, generally nonflowering plant in year two, flowering and dying after flowering in year three. Some plants may produce small Revised Jesup's Milk-Vetch Recovery Plan 14 numbers of flowers in the second year, in which case the plants will typically flower again the following year. Alternatively, depauperate plants may live for 4 years with minimal flowering. Some vegetative plants survive to a fourth year. Self-fertilization is commonly documented in the genus Astragalus, facilitated by simultaneous maturation of anthers and stigmas (Barneby 1964). Experiments that excluded pollinators from flowers have shown Jesup's milk-vetch to be capable of selffertilization. The most common insect visitors of Jesup's milk-vetch flowers are bumblebees identified as Bombus vagans vagans Smith (USFWS, 2019)

**Reproduction Narrative**

Adult: Jesup's milk-vetch plants emerge in April (or as soon as ice cover and temperature permits), and bloom in early- to mid-May. Flowering times are variable year to year (Dunlop 1994). Dunlop (1994) observed that the plants closest to the water's edge at all three sites are the last to flower, possibly reflecting longer periods of spring inundation or a cooling effect on the lower slope. Flowering generally lasts to early July, and seed set occurs from late June to mid-July (Brumback 2009). Most fruits have dehisced by early July. Some fruiting stems have typically withered by mid-August, but vegetative stems usually remain green until September or October (Brumback and Piantedosi 2018a). Seed germination is delayed until the following year (or later) (Brumback 2009). This latter group typically includes depauperate individuals that have not previously flowered or produced very sparse blooms. (USFWS, 2019)

**Habitat Type**

Adult: Terrestrial (USFWS, 2019)

**Habitat Vegetation or Surface Water Classification**

Adult: Calcareous bedrock outcrops which are ice-scoured annually (USFWS, 2019)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2019)

**Habitat Narrative**

Adult: Jesup's milk-vetch inhabits bedrock outcrops of chlorite or phyllite schist that are periodically scoured by flooding and ice-rafting along the Connecticut River. As such, these riparian ledges are sparsely vegetated; however, they support a globally rare natural community type and several rare plant species in addition to Jesup's milk-vetch. Plants at each site occupy a narrow band between a lower bound determined by typical water levels during the growing season and an upper bound defined by the deep shade of long-lived woody vegetation that is at a high enough elevation to survive the occasional severe scouring by ice. (USFWS, 2019)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms are unknown for this species, although there is evidence that long distance dispersal is extremely unusual. Given the proximity of the populations to water, it is reasonable to expect that flooding, especially spring freshets, would play a role in transporting overwintering seeds among sites. However, seed dispersal may be naturally limited since mature seeds readily sink in water (Kane 2011a, It is probable that the vast majority of seeds produced by a population likely remain in close proximity to parent plants and that long-distance dispersal is rare. (USFWS, 2019)

***Population Information and Trends***

**Population Trends:**

Tenuous (USFWS, 2019)

**Species Trends:**

Stable (inferrred from USFWS, 2019)

**Number of Populations:**

3 (USFWS, 2019)

**Population Size:**

Approx 736 natural plants (USFWS, 2019)

**Population Narrative:**

This species is known from only three extant populations along the Connecticut River in New Hampshire and Vermont: Sumner Falls and Jarvis Hill (NH) and Hartland Ledges (VT). These populations comprised 736 plants in 2018 (not including introduced plants at one site). Population sizes are highly variable among years; in the years between 1997 and 2018, the global population has ranged from 260 plants to over 2,000 plants. As thie 2018 population value is based on careful searches of all available habitat at all known populations, it is unlikely to underestimate actual population size by a considerable amount. The Jarvis Hill population has been consistently and significantly larger than the other two populations throughout this time period. Despite intensive surveys, no additional extant Jesup's milk-vetch populations were discovered, although potential suitable habitat was documented. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Herbivory (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory has been noted on the stems, leaves, fruits, and seeds of Jesup's milk-vetch since 1990. The major herbivores remain unidentified, but deer and woodchucks were suspected in 1990 and 1992, respectively. The proportion of stems affected is generally small (less than 10 percent). Nothnagle noted the loss of an "estimated 95 percent of flowers to herbivory in 1998" without identifying the herbivore (NHNHI 2002). No similar incidents of large-scale herbivory have been documented in the last decade. (USFWS, 2019)

**Stressor:** Trampling (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Trampling of plants has been noted at Sumner Falls on several occasions: 1990, 1992, and 2001. Sumner Falls receives many visits from kayakers who shoot the nearby rapids, fishermen, and other recreational users. Picnicking, boat landing, and campfire building can threaten plants. Vandalism was noted in the past; several plants were "pulled up" in 1990. Likewise, activities nearby can also have inadvertent impacts: a crew erecting signage at Sumner Falls in 2003, for example, dumped brush very near to the plants (but fortunately did not damage any). With so few plants present at the site, the population is vulnerable to even small-scale disturbances. Other sites are not as attractive for boat landings, they are too steep to access from the water and overland access points are in private ownership. (USFWS, 2019)

**Stressor:** Land use change (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because Jesup's milk-vetch habitats typically occur far apart from each other, colonization of new habitat and establishment of new populations depends on rare long-distance dispersal events. Land use changes that reduce the availability of appropriate Jesup's milk-vetch habitat can reduce the prospects for successful establishment of new populations. Residential and recreational development is increasing along the Connecticut River. While local regulations may prevent siting of new development in the riparian buffers that provide potential habitat for Jesup's milk-vetch, logging and construction activities in the upland areas can cause erosion of shoreline habitats, lead to dumping of materials (e.g., coarse woody debris) in shoreline habitats, and result in increased human visitation to shoreline habitats. These effects can result in degradation of Jesup's milk-vetch habitat and trampling of Jesup's milk-vetch plants. (USFWS, 2019)

**Stressor:** Invasive Species (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Jesup's milk-vetch relies on the availability of open habitat, which is maintained in an early-successional state by periodic flooding and ice scour. Populations of black swallowwort, shrubby honeysuckle, cypress spurge, and purple loosestrife have been noted by surveyors at one or more sites since 1997. As of 2002, all of these species were present at all three sites (with the exception of purple loosestrife, which occurred only at Hartland Ledges and Jarvis Hill) and (with the exception of cypress spurge) are the focus of intensive removal efforts. Recently, Cardamine impatiens (bushy rock-cress) is being treated manually at Sumner Falls and Hartland Ledges (Brumback and Piantedosi 2018b) (appendix 3 and 4). The Hartland Ledges site has the highest percent cover of invasive species. Black swallowwort appears to be spreading more rapidly than other species, particularly at Hartland Ledges, where a nearby railroad bed is infested in places with up to 100 percent cover and plants are rapidly spreading into the surrounding forest and down onto the riverbank and the rock outcrops where Jesup's milk-vetch grows. Despite repeated herbicide application to control swallowwort at Hartland Ledges, the upslope population by the railroad continues to shed seed, providing the source for recruitment of this highly invasive species. Shrubby honeysuckle has been increasing more slowly. Several other native, aggressive species are also increasing in cover at the sites, including Toxicodendron radicans (poison ivy) and Apios americana (ground-nut) at Hartland Ledges. (USFWS, 2019)

**Stressor:** Problems intrinsic to small populations (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Jesup's milk-vetch populations are subject to dramatic "boom and bust" cycles. In 2003, 2009, and 2012 through 2014, all three populations were at some of their lowest numbers since consistent monitoring began in 1997 (appendix 6). While apparent rebounds have occurred after some of the precipitous declines (e.g., 2004 and 2010), monitoring data indicate that these are likely to be followed by future dips under normal conditions. However, extreme storm events in 2008, 2009, and 2011 may have been responsible for the prolonged decline in total plant numbers from 2012 through 2014. Demographic stochasticity can lead to random extinction, and small populations are particularly vulnerable (Morris and Doak 2002; Farnsworth 2008). These populations are also clearly subject to environmental stochasticity, which further compounds year-to-year variation in population size and is a major driver of extinction probabilities in rare plants.The distinctiveness of the three populations is critical to maintaining the genetic diversity represented by each population. The loss of any population would result in a substantial loss of the species-wide genetic diversity and potentially impact the species' ability to respond to stochastic changes in the environment, including climate change. Maintaining genetic representation of all three populations will be critical in the recovery of the species. (USFWS, 2019)

**Stressor:** Hydrological alteration (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The extant Jesup's milk-vetch populations are located in the 90-mi (145-km)8 stretch of river with flows directly affected by two hydropower dams, Wilder Dam (Wilder, VT/Hanover, NH) and Bellows Falls Dam (Rockingham, VT/Walpole, NH) (NHNHB 2014). Specifically, the three Jesup's milk-vetch populations occur in the 25 mi (40 km) of free-flowing river between the two dams. The Sumner Falls population is approximately 9.5 river-mi (15 river-km) downriver of Wilder Dam, the Hartland Ledges population is approximately 12.5 river-mi mid-way between the Wilder Dam and BellowsFalls Dam (20 river-km), while the Jarvis Hills population is above the head of the impoundment for the Bellows Falls Dam. Both dams influence the hydrology of the Connecticut River in the vicinity of the Jesup's milk-vetch populations. (USFWS, 2019)

**Stressor:** Climate change (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change models predict that precipitation will increase by 14 percent with the greatest increase in the fall and winter and in the form of rain rather than snow (Runkle et al. 2017a; Runkle et al. 2017b). In Jesup's milk-vetch habitat, riverbank ledges are kept clear by ice scour and spring flooding. These disturbances remove other vegetation that might colonize Jesup's milk-vetch habitat and shade out Jesup's milk-vetch seedlings (USFWS 1989), and/or deposit alluvial sediment to renourish Jesup's milk-vetch plants. The most significant annual floods currently occur during spring runoff, with decreasing flows during the summer. With increasing winter temperatures and winter precipitation in the form of rain, the decrease in snowpack may result in reduced spring flooding and ice scour, critical components to reduce competing vegetation in the rock outcrops. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
Demographic criteria: 1a: A minimum of four persisting populations occurring within the historically known and/or expanded that conserve the genetic diversity of the species. (USFWS, 2019)

Demographic criteria: 1b: A persisting population is defined as having a site-specific median number of total plants (excluding transplants)11 over 5 consecutive years (based on a minimum of one generation) as described below. (i) Sumner Falls: A median of 113 natural plants; (ii) Hartland Ledges: A median of 132 natural plants; (iii) Jarvis Hill: A median of 477 natural plants; (iv) expanded range populations: (1) sites similar in area to the Sumner Falls population: a median of 100 plants; and (2) sites similar in area to the Jarvis Hill population: a median of 400 plants. (USFWS, 2019)

Threats-abatement criteria: 2a: A long-term landowner agreement or other mechanism is in place for each of the four persisting populations that provides: (i) protection against habitat loss. For example, forested buffers are established/maintained between a population and developed land (agricultural land, development, etc.); and (ii) access for long-term monitoring and management. (USFWS, 2019)

Threats-abatement criteria: 2b: A rapid response plan is in place for each of the four persisting populations that addresses new threats (e.g., invasive species) and the need for population augmentation (adaptive management). (USFWS, 2019)

Recovery Priority: 6

**Delisting Criteria:**
Demographic criteria 1a: A minimum of six resilient populations occurring within the historically known and/or expanded ranges that conserves the genetic diversity of the species. (USFWS, 2019)

Demographic criteria 1b: A resilient population is defined as having a site-specific median number of plants and a median number of total inflorescences (excluding transplants) over 8 consecutive years (based on a minimum of three generations) as described below. (i) extant populations: (1) Sumner Falls: A median of 113 natural plants and a median of 193 inflorescences; (2) Hartland Ledges: A median of 132 natural plants and a median of 507 inflorescences; (3) Jarvis Hill: A median of 477 natural plants and a median of 4337 inflorescences; (ii) expanded range populations: (1) sites similar in area to the Sumner Falls population: A median of 100 plants and a median of 193 inflorescences; and (2) sites similar in area to the Jarvis Hill population: a median of 400 plants and a median of 4,337 inflorescences. (USFWS, 2019)

Threats-abatement criteria 2a: A long-term landowner agreement or other mechanism is in place for each of the six resilient populations that provides: (i) protection against habitat loss. For example, forested buffers are established/maintained between a population and developed land (agricultural land, development, etc.); and (ii) access for long-term monitoring and management. (USFWS, 2019)

Threats-abatement criteria 2b. A rapid response plan is in place for each of the six resilient populations that addresses new threats (e.g., invasive species) and the need for population augmentation (adaptive management). (USFWS, 2019)

**Recovery Actions:**
- Protect extant and introduced populations: Securing Jesup's milk-vetch populations requires protecting them from land and water use impacts that cause habitat loss or degradation or result in direct mortality of plants. Protect occupied habitat with conservation easements, management agreements, or acquisition. Conserve vegetative buffers at Jesup's milk-vetch populations. Develop protective hydrological management regimes for dams potentially impacting historically known and expanded range populations. (USFWS, 2019)
- Establish additional populations: Increasing population redundancy for Jesup's milk-vetch requires establishment of additional populations. Introduced populations should represent the range of genetic diversity of the three populations. Because no suitable introduction sites have been identified within the historically known range to date, populations must be established at suitable introduction sites outside the historically known range. (USFWS, 2019)
- Evaluate status of existing populations: Annual quantitative monitoring of historically known and expanded range populations is necessary to assess population trends and status. Annual monitoring of Jesup's milk-vetch populations will determine whether augmentation is warranted and whether there are a sufficient number of plants to allow for seed collection. Annual monitoring for the presence and density of invasive plant species will

determine recovery management actions needed to maintain viable Jesup's milkvetch populations, or document new threats from future invasive species. (USFWS, 2019)

- Manage Habitat: Securing Jesup's milk-vetch populations requires managing their habitats to reduce threats from invasive plant species, recreational activities, and herbivory. Habitat management protocols must be thoroughly documented and data collected in a statistically meaningful way so that successes can be replicated elsewhere and future failures averted. (USFWS, 2019)
- Bank seeds and perfect propagation and transplantation techniques: Seed banking provides insurance against catastrophic declines in natural populations by enabling the propagation of seedlings for population augmentation or introduction efforts. Genetic representation of all populations is maintained by collecting and preserving seed from the three extant populations. Jesup's milk-vetch seeds are collected and banked at NPT. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Protect extant and introduced populations. Secure conservation easements or management agreements to ensure that population monitoring, invasive plant species management, and population augmentation will continue. 2. Establish additional populations by conducting conservation introductions and translocations in suitable habitat. 3. Establish rapid response plans that incorporate decision making matrices for invasive plant species management and population augmentation. 4. Bank seeds and perfect propagation and transplantation techniques. Experiment with direct seeding. 5. Investigate the potential for early spring high water release from upriver hydropower projects. Identify the flows needed to scour occupied habitat. (USFWS, 2021)

**References**

USFWS. 2019. Jesup's Milk-vetch (Astragalus robbinsii var. jesupii) Revised Recovery Plan. U.S. Fish and Wildlife Service, Concord, New Hampshire. 71 pp.

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# SPECIES ACCOUNT: *Astragalus tener var. titi* (Coastal dunes milk-vetch)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/12/1998; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A small annual herb with slender stems, usually 1-1.2 dm tall. Flowers (March-May) are 5-6 mm long, lavender to purple in color. Seed pods are straight to half-moon shaped, 1-2.5 cm long (NatureServe, 2015).

**Taxonomy**

A member of the pea family (Fabaceae) (USFWS, 2009).

**Historical Range**

It was once a regional endemic with a range including San Diego, Los Angeles, and Monterey counties; it was never very common in its range though, being restricted to a very specific habitat (NatureServe, 2015).

**Current Range**

Today it is only verified at one area in Monterey County. The total known range in the 3 areas adds up to about 270 sq mi (NatureServe, 2015). It is currently known from one highly fragmented population located on a coastal terrace grassland along 17-Mile Drive in Pebble Beach on the Monterey Peninsula, Monterey County, California. The population is bordered along one side by the Pacific Ocean and the other side by a golf course; 17-Mile Drive bisects the population. (USFWS, 2019).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, self-fertilization (USFWS, 2009)

**Breeding Season**

Adult: March - May (USFWS, 2004)

**Reproduction Narrative**

Adult: Crossing studies conducted by Liston (1992) indicate that the plants are self-compatible and capable of self-fertilization. Doak et al. (2000) investigated reproductive biology. They found that seed set could be high; mean seed set in plants not damaged by gophers or other herbivores was 44 seeds per individual, and of 207 pods checked for seed production, approximately 70 percent had a seed set of between 4 and 7 seeds per pod. At the same time, they observed only one pollinator in the field over the course of 3 years, and also that greenhouse-grown plants without access to pollinators set high numbers of seed. Based on these combined observations, they concluded that this species is a successful self-pollinator and that pollinators are not a strong concern in the establishment and maintenance of populations (Doak et al. 2000) (USFWS, 2009). Astragalus tener var. titi flowers between March and May. Small bees have been presumed to be its main pollinators based on floral structure (USFWS, 2004).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal terrace, dune (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs within 100 ft. of ocean surf zone, 25 ft. elevation; shade-intolerant (USFWS, 2004)

**Spatial Arrangements of the Population**

Adult: Scattered clumps (USFWS, 2009)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 2004)

**Habitat Narrative**

Adult: The extant population grows in shallow swales on the flat surface of a coastal terrace. These depressions hold standing water during wet winter and spring seasons. The substrate is a loamy fine sand. The plants are associated with the non-native hottentot fig (Carpobrotus edulis) and cut-leaf plantain (Plantago coronopus). The environmental specificity is very narrow; it is only known from 3 small areas along the immediate coarse in sandy soil (NatureServe, 2015). The entire distribution of the population occurs on patches of remaining habitat that is interspersed with roads, trails, golf greens, and other recreational facilities (USFWS, 2009). Astragalus tener var. titi occurs on sandy soil within 30 meters (100 feet) of the ocean surf zone and 25 ft. above sea level. plants occur primarily on Antioch soils, with a few colonies found on compacted Sheridan soils (Jones and Stokes Associates 1996). Astragalus tener var. titi plants will germinate and grow to healthy maturity in areas of low-level disturbance, such as that caused by gophers or light pedestrian traffic (Doak et al. 2000, M. Stromberg in litt. 2002). Research conducted on plants under cultivation confirms that any competition or shading will result in unhealthy plants (V. Yadon, in litt. 2002, M. Stromberg in litt. 2002) (USFWS, 2004).

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 2004)

**Dispersal/Migration Narrative**

Adult: Under cultivation, seed capsules may burst and throw their seeds up to 2 meters (6.5 feet) (V. Yadon in litt. 2002). Many capsules are not dehiscent and simply drop to the soil where they may float to other areas to colonize if those areas become flooded during winter rains (V. Yadon, in litt. 2002) (USFWS, 2004).

***Population Information and Trends***

**Population Trends:**

Decline of 70 - 90% (NatureServe, 2015)

**Species Trends:**

10 - 30% decline (NatureServe, 2015)

**Number of Populations:**

1 (USFWS, 2022)

**Population Size:**

Variable; 100 - 7,000 depending on climatic conditions (USFWS, 2009). Approximately 2,000 individuals were observed in 2011, the last year that the population was surveyed. (USFWS, 2019).

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

Very vulnerable due to habitat type and small size. Long term trend is one of steep decline due to habitat destruction in 3/4 of its range. This species has experienced a long-term decline of 70-90%. The short term trend is one of decline (10 - 30%) due to presence on private land. The Pebble Beach Corporation site on the Monterey Peninsula had 4000 plants in 1995. 6 known EO's, but 5 are extirpated or historical. Only 1 extant occurrence is known (NatureServe, 2015). Annual population numbers have fluctuated between less than 100 and approximately 7,000, depending on winter and spring climatic conditions (USFWS, 2009).

***Threats and Stressors***

**Stressor:** Habitat loss and degradation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although vehicles have been prevented from entering the habitat of the plant in one roadside area, the individuals remain vulnerable to vehicles as well as trampling from other recreational activities along other portions of the roadside. Inundation by salt water and beach cobble during storm events may be new threats that may affect the portion of the population closest to the ocean. Little opportunity for population expansion is available adjacent to the existing population because habitat has already been converted to other uses, including roads, trails, and golf courses (USFWS, 2009).

**Stressor:** Predation (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** California voles (Microtus californicus), which are known to harvest seeds of many species in general (Martin et al. 1951, Peronne 2002), are known to occur in the area occupied by the plant (Yadon in litt. 2002; Stromberg in litt. 2002). No data have been gathered to determine the extent of this threat. Since the time of listing, herbivory by snails (various species), slugs (various species), and aphids (Aphis spp.) has also been observed on both vegetative and reproductive structures (Doak et al. 2000, Stromberg in litt. 2002) (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The existence of only one population and small number of individuals in the population place Astragalus tener var. titi at extreme risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, although the plants are apparently self-compatible and capable of self-fertilization, the small size of the population makes it difficult for this species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The extent to which such events are caused by climate change and the extent to which it could affect Astragalus tener var. titi are unknown at this time (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
1. At least five viable populations (i.e., populations that are stable or increasing based on multiple years of monitoring, including at least two populations in San Diego or Los Angeles Counties) occur on suitable habitat with few to no nonnative competitors, and no threats from trampling. The area surrounding each population should allow for movement and expansion (USFWS, 2009).

2. A minimum of five populations are on land that is permanently protected from development (e.g., residential, commercial, recreational, etc.) including the population that currently exists on Pebble Beach Company and Monterey Peninsula Country Club property. Funds must be

available for appropriate long-term management. Protected habitat must be of adequate size and configuration to ensure that ecosystem and community processes (e.g., hydrologic regime, food webs, pollinator fauna, coastal dune community associates, and associated species) are maintained, and an adequate diversity of sites exist for colonization of new areas as microhabitat conditions change (USFWS, 2009).

3. Site selection, restoration, and plant reintroduction has been initiated in at least two historical localities in Los Angeles or San Diego Counties. These two reintroduced populations will be considered as part of the five populations of plants described in 1 (a) and 1(b) above (USFWS, 2009).

4. The populations of plants are being adequately maintained, such that encroachment by nonnative plants, excessive herbivory, fire prevention activities, or other threats are not negatively affecting Astragalus tener var. titi directly or indirectly (USFWS, 2009).

5. The 17-Mile Drive population and additional populations have been appropriately managed such that monitoring has determined that these populations are stable or increasing for a minimum of 3 consecutive years (USFWS, 2009).

6. A seed bank has been established at a recognized institution that is certified by the Center for Plant Conservation (CPC) (USFWS, 2009).

Recovery Priority Number: 6C

**Delisting Criteria:**
Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: protection from recreational activities such as hiking, picnicking, equestrian use, and golfing; research is needed on soil seed bank dynamics. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts directly adjacent to occupied patches to allow for expansion, especially to offset losses of patches along the immediate coast due to storm surge and saltwater intrusion; and three additional, new populations are established and protected where appropriate, with a goal of increasing redundancy and representation with the establishment of new populations on the Central Coast, in Los Angeles County, and San Diego County. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. We expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

**Recovery Actions:**

- Secure and protect existing populations and habitat on private or unprotected lands through willing landowners (USFWS, 2004).
- Manage lands to control or eliminate threats to the plants and their habitat (USFWS, 2004).
- Conduct research to document life history characteristics and plants' responses to vegetation management (USFWS, 2004).
- Survey for additional populations and suitable habitat for reintroduction or reestablishment and establish new populations (USFWS, 2004).
- Develop management strategies and monitor populations to determine effectiveness of management (USFWS, 2004).
- Coordinate recovery actions with other listed species or species of concern (USFWS, 2004).
- Develop and implement a public outreach program (USFWS, 2004).
- Reevaluate recovery criteria and revise recovery plan based on knowledge obtained from research, monitoring, and management (USFWS, 2004).
- Work with Pebble Beach Company and Monterey Peninsula Country Club to clarify current management practices within Astragalus tener var. titi habitat and determine if any modifications could be made to improve the status of the taxon (USFWS, 2009).
- Develop and implement a population monitoring design that focuses on aerial extent of populations rather than exact population counts, and includes the full range of the population (USFWS, 2009).
- Experiment with establishment of new populations in other coastal terrace habitat on the Monterey Peninsula or at Point Lobos State Reserve. If these efforts are successful, attempts to establish other populations could be undertaken in Los Angeles and San Diego Counties (USFWS, 2009).
- Survey historical occurrence areas and potential habitat in San Luis Obispo, Los Angeles, and San Diego counties to detect populations and assess habitat for potential restoration and reintroduction. This effort should include a broader habitat definition to accommodate previously overlooked potential habitat (USFWS, 2009).
- Continue with research on seed characteristics, particularly to determine whether there is a difference in seed viability between those produced from self-fertilization and those produced by cross-pollination (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Establish a minimum 10-year monitoring program for coastal dunes milk-vetch on the Monterey Peninsula that includes the entirety of the population. The monitoring program should include annual systematic surveys of abundance and more frequent assessments of invasive species, trampling, or other emergent threats. 2. Evaluate the existence of a seed bank at sites in Monterey that have been recently occupied (within the past 3 years) and sites that have not been occupied for at least 5 years. 3. Conduct restoration and outplanting trials at suitable sites in Monterey County. 4. Conduct surveys, site evaluation, restoration and outplanting trials at sites in Los Angeles and San Diego County after successful trials in Monterey County (USFWS, 2022)

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# SPECIES ACCOUNT: *Astrophytum asterias* (Star cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/18/1993; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

A small, spineless, disk or dome-shaped member of the Family Cactaceae (Cactus Family). It is 2 to 15 centimeters (1S6 inches) across, and up to 7 centimeters (3 inches) tall. Star cactus is dull green-to-brown in color, often speckled with a covering of tiny white scales. The body is divided into eight, vaguely triangular sections. Each triangular section has a central line of circular indentations (areoles) filled with whitish, wooly hairs. During periods of adequate moisture, star cactus is usually a dull green color; however, during droughts, the cactus becomes brownish and loses fullness so that it becomes flush with the ground and almost perfectly camouflaged (Figure 2). Flowers are yellow with orange centers, and up to 15 centimeters (6 inches) in diameter. The fruits of star cactus are green to grayish-red, somewhat obscured by white wooly hairs, about 1.25 centimeters (0.5 inches) long, oval, and fleshy when mature. The seeds are glossy, dark brown with an enlargement of a chamber of the seed coat forming a flaring collar that encircles the hilum (Damude and Poole 1990, Benson 1982) (USFWS, 2003).

**Taxonomy**

This plant is a member of the cactus family (Cactaceae) (USFWS, 2016). Astrophytum asterias was originally collected by Baron von Karwinsky in 1843 and described as Echinocactus asterias by Joseph Zuccarini in 1845 (Damude and Poole 1990, USFWS 2003). Charles Lemaire described the new genus Astrophytum in 1868, into which he placed A. asterias. Common names for A. asterias include: Biznaga-algononcillo de estrella, sand dollar, sea urchin star cactus, and false peyote (Integrated Taxonomic Information System 2011) (USFWS, 2013).

**Historical Range**

The historical range of star cactus included Hidalgo, Starr, Zapata, and possibly Cameron Counties in South Texas and the States of Nuevo Leon and Tamaulipas in Mexico. The Nuevo Leon site near Linares was probably extirpated by collectors (USFWS, 2003). When listed in 1993, only two extant populations of A. asterias were known, one population in the United States, in Starr County, Texas; and one population in Tamaulipas, Mexico (USFWS, 2013).

**Current Range**

Currently only known from Starr County in extreme south Texas and the adjacent state of Tamaulipas, Mexico (NatureServe, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: Two growth rates were determined using different calculation methods. Based on the assumption that the mean annual growth rate is constant among all size classes, the growth rate was determined to be 2.71 millimeters (mm)/year (0.10 in/year). The second method took into account the premise that growth rates differ by size class (growth rates range from -0.85 – 3.65 mm/year (-0.03 – 0.14 in/year). This resulted in the mean diameter growth rate of 2.1 mm/year (0.08 in/year) (USFWS, 2013).

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2013)

**Dependency on Other Individuals or Species**

Adult: Diadasia rinconi (USFWS, 2013)

**Breeding Season**

Adult: March - May (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2013)

**Reproduction Narrative**

Adult: Flowers usually bloom from March - May, opening in the morning and closing in the evening. Astrophytum asterias is an obligate outcrosser (USFWS 2003, 2013). Using the estimated growth rates, it would take 15 - 25 years to reach the 4-cm (1.57 in) benchmark for reproductive maturity. The cactus specialist bee Diadasia rinconis was found to be the most effective of all the observed pollinators (Janssen et al. 2010). Other insects visited the flowers more frequently but because of low effectiveness, they are not considered the most important (Janssen et al. 2010) (USFWS, 2013). Fruiting occurs April through June (USFWS, 2003).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Historical: subtropical grassland or grassland/savannah; current: shrubland, non-native grassland (NatureServe, 2015); Tamaulipan thornscrub (USFWS, 2013)

**Dependencies on Specific Environmental Elements**

Adult: Partial shade (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Currently, this species is found in sparse, fairly open brushland. It is most often found growing in gravelly, sometimes saline, clays or loams in the partial shade of other plants or rocks. The vegetation in these areas was originally a subtropical grassland or grassland/savannah, but fire suppression, overgrazing, and pasture improvement have converted it to thorny shrublands and stands of non-native pasture grass. It is uncertain what habitat this species occupied in the original grassland ecosystem (NatureServe, 2015).

Astrophytum asterias occurs on flats in shrublands and grasslands in Tamaulipan thornscrub. Soil analysis indicates that the highest density of A. asterias was found on saline-sodic, followed by saline soils (Janssen et al. 2010) (USFWS, 2013).

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms in the wild are virtually unknown. Mature fruits appear to disintegrate while still attached to the plant and leave a small cluster of seed on top of the plant. Wind and rain may carry the seeds away to establishment sites. Small rodents may also store the seeds at cache sites. Additionally, ants may play a role in seed dispersal (USFWS, 2013).

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

U.S.: 24; Mexico: 9 (USFWS, 2013)

**Population Size:**

U.S.: 5,125; Mexico: 1,275 (USFWS, 2013)

**Population Narrative:**

This species has experienced a short term decline of > 30%; the Nuevo Leon site is believed to have been extirpated by collectors, and the Tamaulipas site has been reduced to very few individuals (NatureServe, 2015). In Starr County, Texas, 2011 surveys brought the known total of extant A. asterias populations to 24, containing a total of 5,125 individual plants. There are nine populations in Mexico, totaling 1,275 plants (Janssen et al. 2010, Martinez-Avalos 2002) (USFWS, 2013).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The leading threat to A. asterias throughout its range currently, and at the time of listing, is habitat loss. All A. asterias populations in Starr County, Texas, are located on private property; the majority of which do not have signed conservation agreements. An extensive land area in Starr County has been root-plowed and converted to buffelgrass (Pennisetum ciliare) pasture; this has presumably destroyed an unknown amount of star cactus habitat. Mechanical disturbance makes habitat unsuitable for A. asterias. An additional but unknown amount of habitat has probably been lost to urban and residential development and highway construction. Highly competitive introduced grasses (specifically buffelgrass) are clearly incompatible with A.

asterias conservation. Buffelgrass reduces native vegetation coverage, density, species richness, and diversity (Sands et al. 2009). Seismic surveys, oil and gas well development, and other construction related to oil and gas exploration can cause surface damage and irrevocably damage or completely destroy the habitat (Conner 2011) (USFWS, 2013).

**Stressor:** Overutilization due to collection (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Collectors for many years have removed cacti for private collections. Astrophytum asterias are collected by individuals for personal use or trade, sometimes being mistaken for peyote (Lophophora williamsii). The demand for rare cacti by collectors has escalated in the United States and in other countries, including Asia and Europe (Westlund 1991). In 1991 the TPWD published a report on the cactus trade, monitoring impacts by investigating 72 individual collectors, family nurseries, and commercial nurseries (Westlund 1991). Although many of these collectors/growers had less than 50 individual cactus plants, representing only three to four species, one "digger" had more than 1,000 freshly dug cacti of 13 subspecies. Four hundred field-collected A. asterias were observed in nurseries, and eight mail order catalogs had A. asterias listed for sale (USFWS, 2013).

**Stressor:** Disease and predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the U.S. and Mexican populations, the leading cause of mortality was found to be herbivory by Mexican-ground squirrels. It does appear that during periods of drought, the level of herbivory is increased. Other causes of mortality were found to be insect herbivory and fungal infections. Combination of pathogens and herbivory was shown to greatly reduce the population by over 50 percent (Martinez-Avalos 2007). Several animal and insect species appear to utilize and destroy A. asterias. The threat to A. asterias continues to remain high, especially during periods of drought (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Rising temperatures might enable the species to survive further north than at present, but might also reduce the southern limit of the range. Similarly, changes in the frequency and amount of precipitation could favor a shift in geographic range or habitat type. However, the limited seed dispersal range, and the existence of new barriers to migration could impede alteration of the range of A. asterias (Malanson and Cairns 1997). Changes in temperature and rainfall amounts and patterns could alter the species' competitive advantage in the unique micro-habitats it now inhabits. Regardless of how these changes may affect the autecology of A. asterias, the altered synecology may be far more significant. For example, higher winter temperatures could increase competition from invasive grasses (Patterson 1993) (USFWS, 2013).

**Stressor:** Reduction of genetic variability (USFWS, 2013)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** At the time of listing, the one site known to have the star cactus present contained fewer than 2,100 plants. Genetic variability and viability decrease with reduced numbers of plants across the range (Ledig 1986). This, along with the pressures of other natural and anthropogenically-induced threats, increases the possibility of extinction of the species in the wild (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
1. Maintain or establish ten geographically distinct, fully protected, self-sustaining populations of star cactus in the United States or Mexico, each with a minimum of 2,000 individuals and an age class structure reflecting that plants are reproducing and becoming naturally established within the population (USFWS, 2013).

2. Develop and implement a formal conservation agreement between the U.S. and Mexico (USFWS, 2013).

Recovery Priority Number: 2

**Delisting Criteria:**
1. Over a 60-year period, maintain the 5 fully protected sites in each designated recovery unit at the MVP of 2,500 individuals per site with at least 50% being of reproductive age. All sites will be fully protected, self-sustaining sites occurring across the species known range within each recovery unit. (USFWS, 2019)

**Recovery Actions:**
- Protect and manage existing star cactus populations and habitat in the United States and Mexico (USFWS, 2003).
- Gather information for management and monitoring programs for star cactus (USFWS, 2003).
- Search for new populations of star cactus in the United States and Mexico (USFWS, 2003).
- Establish and maintain a botanical garden population of star cactus (USFWS, 2003).
- Establish new populations in natural habitat as necessary to meet reclassification criteria (USFWS, 2003).
- Develop and implement a formal conservation agreement for star cactus between the United States and Mexico through the Trilateral Agreement (USFWS, 2003).
- Develop a public education and awareness program for the species (USFWS, 2003).
- Evaluate progress toward recovery, management direction, and status of information needed for development of delisting criteria within five years (2008-2009) (USFWS, 2003).
- Continue periodic monitoring of the known populations in Texas and Mexico to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2013).
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. Work with private landowners to establish a private landowner support group and pursue conservation agreements with landowners (USFWS, 2013).

- Conduct surveys of high-potential habitat within the known range of the species in South Texas and Mexico, focusing on sites that have not previously been surveyed (USFWS, 2013).
- Develop an official reintroduction plan for A. asterias. Collect seeds from the known populations, propagate in a greenhouse to produce seedlings, and reintroduce at protected sites, in accordance with Service policy on controlled propagation of endangered species (65 FR 56916) (USFWS, 2013).
- Although the recovery plan (USFWS 2003, p. 13) stated that at least two distinct tracts of National Wildlife Refuge (NWR) land in Texas have the type of soil and habitat necessary for A. asterias reintroduction, and Recovery Action 5 further stated that reintroduction could be implemented on Lower Rio Grande Valley NWR, subsequent habitat assessments, conducted by two separate teams of star cactus experts (in 2005 and in 2010), did not find any suitable star cactus habitat on any existing tracts of Lower Rio Grande valley NWR. However, this refuge could target some future land acquisitions to include suitable habitat for A. asterias (USFWS, 2013).
- Amended recovery criteria 1. Maintain or establish at least 5 sites (>1 km of separation between sites) within each of a total of 3 designated recovery units in Texas and Mexico. Recovery units will be based on geology and/or soils. Each site will contain at least 2,500 individuals, 50% of which will be of reproductive age as determined by a size of ≥ 4 cm diameter. The sites must occur across the species known range within each recovery unit; however, coalescence of sites due to recovery or discovery of new sites will not reduce the number of recognized sites. 2. All sites described above in downlisting criterion 1 must be fully protected in perpetuity and managed appropriately for the species, its habitat, and pollinators. 3. Develop and implement a formal conservation agreement for star cactus between the U.S. and Mexico. (USFWS, 2019)

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# SPECIES ACCOUNT: *Atriplex coronata var. notatior* (San Jacinto Valley crownscale)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An annual herb, 1-3 dm tall, with gray-scaly herbage. Flowers are inconspicuous, with rounded, often bumpy bracts developing in the fruiting stage. Usually flowers in April and May and sets fruit by May or June (NatureServe, 2015).

**Taxonomy**

Atriplex coronata var. notatior (San Jacinto Valley crownscale) was first described by Willis Jepson in 1914, eased on specimen material he collected ii 1901 from the dried bed of San Jacinto Lake. Riverside County, California This taxon was considered a minor variant in a monographic treatment of the genus Atriplex (Hall and Clements 1923) and was generally not recognized as distinct from A. coronata until Munz (1974) concurred in Jepsons findings in his treatment of southern California plants (USFWS, 1994). It is a member of the Chenopodiaceae (goosefoot family) (Zacharias 2012, p. 629) (USFWS, 2012).

**Historical Range**

See Current

**Current Range**

Restricted to the San Jacinto, Perris, Menifee, and Elsinore Valleys of western Riverside County, California. Occurrences are associated primarily with the San Jacinto River and Old Salt Creek tributary drainages, with an additional occurrence near Lake Elsinore (USFWS 2008) (NatureServe, 2015).

**Critical Habitat Designated**

Yes; 4/16/2013.

**Legal Description**

On April 17, 2012, the U.S. Fish and Wildlife Service (Service) proposed to designate critical habitat for San Jacinto Valley crownscale (Atriplex coronata var. notatior) under the Endangered Species Act of 1973, as amended (77 FR 23008 - 23057). On April 26, 2013, the Service issued a Final Rule in which no critical habitat was designated for San Jacinto Valley crownscale (78 FR 22626 - 22658). The Final Rule states "The Secretary is exercising his discretion to exclude approximately 8,020 ac (3,246 ha) of previously proposed critical habitat for Atriplex coronata var. notatior. The Service determined that the benefits of exclusion outweigh the benefits of inclusion for lands previously proposed as critical habitat within areas covered under the Western Riverside County Multiple Species Habitat Conservation Plan, the Rancho Bella Vista Habitat Conservation Plan, and the Southwestern Riverside Multi-species Reserve Cooperative Management Agreement." On October 13, 2005, the Service issued a Final Rule that did not designate critical habitat for this species (70 FR 59952 - 59974).

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: April - August (USFWS, 2012)

**Key Resources Needed for Breeding**

Adult: Wind (USFWS, 2012)

**Reproduction Narrative**

Adult: Seeds may remain viable for more than five years, such that a soil seed bank may be present at occupied and formerly-occupied sites (USFWS 2008) (NatureServe, 2015). Atriplex coronata var. notatior is monoecious (plants bear separate male and female flowers on the same plant) and is believed to be wind-pollinated. Atriplex coronata var. notatior is reported to be a prolific seed producer (Ogden Environmental and Energy Services Corporation [OEESC] 1993, p. 27). Seeds generally germinate in the spring as flows recede, flower in April and May, and set fruit by May or June (Bramlet 1992, pers. comm.). The flowering period may extend to August in years when the water recedes late in the spring season (Munz 1974, p. 355; California Native Plant Society [CNPS] 2001, p. 93) (USFWS, 2012).

**Habitat Type**

Adult: Wetland, terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Alkali vernal plain, alkali playa, alkali scrub, alkali grassland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Dynamic hydrological regime (NatureServe, 2015); seasonal large-scale flooding (USFWS, 2012)

**Environmental Specificity**

Adult: Very narrow to narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Occurs in seasonal wetlands, such as floodplains and vernal pools, on slow-draining alkali soils; communities include alkali vernal plain, alkali playa, alkali scrub, and alkali grassland. Sites are typically flooded by winter rains, after which the water drains or evaporates over a variable period of time. Prefers areas with a dynamic hydrological regime that includes both local and large-scale flooding events (USFWS 2008). The environmental specificity is very narrow to narrow (NatureServe, 2015). It is associated with alkaline-saline soils. A hydrologic regime that includes seasonal and large-scale flooding in combination with slow drainage in alkaline soils with low nutrient loads is a key habitat element for this taxon. Atriplex coronata var. notatior is adapted to grow in slow-draining alkaline-saline clay soils, primarily the Willows soil series and, to a lesser extent, the Domino, Traver, Waukena, and Chino soils series (Knecht 1971, p. 23; Bramlet 1993, p. 4) (USFWS, 2012).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Fruits appear capable of floating, which would allow them to be dispersed by annual flood waters (NatureServe, 2015).

***Population Information and Trends***

**Population Trends:**

Decline of 50 - 90% (NatureServe, 2015)

**Species Trends:**

50 - 70% decline (NatureServe, 2015)

**Number of Populations:**

15 (USFWS, 2021)

**Population Size:**

106,000; variable depending on year (USFWS, 2012)

**Adaptability:**

Low (inferred from USFWS, 2012)

**Population Narrative:**

The U.S. Fish and Wildlife Service (1998) estimates that approximately 75% of this taxon's historically suitable habitat has been destroyed or heavily impacted. This species has experienced a long-term decline of 50-90%. Between 1992 and 1998, the number of individuals and area occupied appeared to decline about 70% (U.S. Fish and Wildlife Service 1998). Between 1998 and 2008, the overall extent of the range did not change appreciably, but fragmentation of the spatial distribution within the range (in both space and time) continued due to ongoing threats (USFWS 2008). In 2000, the rangewide population was estimated to be 106,000 individuals (Glen Lukos Associates cited in USFWS 2008); as of 2008, this was still considered the best available estimate. However, the 2000 survey was conducted under the unusually favorable conditions of a two-year suspension of discing and manure dumping by the majority of landowners; these activities have since resumed and are expected to have decreased the number of plants (USFWS 2008). In addition, this annual plant undergoes significant year-to-year fluctuations in the number of standing individuals in response to annual rainfall, extent of winter flooding, temperature, and habitat conditions; therefore, estimates of plant numbers based on short-term data should be used very cautiously (USFWS 2008). Approximately 8 occurrences are believed to have excellent or good viability (CNDDB 2008) (NatureServe, 2015). The Service has defined three geographic locations representing four occurrences of A. c. var. notatior in western Riverside County. A rangewide population estimate of 106,000 individuals of Atriplex coronata var. notatior is based on estimates from surveys conducted in the spring of 2000 (Glenn Lukos Associates, Inc. 2000, p. 15). This taxon exhibits several attributes that might limit its distribution and population growth; particularly habitat specificity and dependence on hydrologic processes represent significant vulnerabilities for Atriplex coronata var. notatior (USFWS, 2012).

***Threats and Stressors***

**Stressor:** Urban and agricultural development (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Alberhill Creek occurrence of Atriplex coronata var. notatior in the floodplain north of Lake Elsinore is located in an increasingly urbanized area that contains both local and private lands. An example of a recent development threat at this occurrence is a proposed subtransmission line (in association with a recently completed electrical power substation), as part of the Southern California Edison Valley-Ivyglen Subtransmission Line and Fogarty Substation Project (W. Worthey, Consultant, 2011, pers. comm.). Efforts are in place to reduce threats to Atriplex coronata var. notatior from urban development and related infrastructure; however, comprehensive surveys have not been conducted for the Lower San Jacinto and Alberhill Creek occurrences. An increase in the addition of manure and biosolids along the Lower San Jacinto River occurrence related to agricultural activities has been observed (USFWS 2008, p. 10). These soils amendments can permanently impact alkaline soil habitat where Atriplex coronata var. notatior is found as a result of: (1) disruption of essential physical or biological features due to continued ground disturbance and (2) alteration of soil chemistry, which causes permanent habitat conversion to a different plant community and expansion of nonnative plants that invade and may outcompete native taxa (Roberts 1999, pers. comm.). The Service believes that these agricultural developments continue as important direct threats to Atriplex coronata var. notatior within the Lower San Jacinto River occurrence. However, based on the best available information, the magnitude of this threat is high for this occurrence because many of the point localities of A. c. var. notatior in portions of the Upper and Lower San Jacinto River occurrences are found on private land that continue to be tilled for dryland farming or negatively impacted by soil amendments. Within the Upper San Jacinto River occurrence, overland flows that cross over agricultural lands into Mystic Lake during major flood events (i.e., winter storms) can transport sediments containing nutrients into the lake, which has increased in recent years as smaller flow events have caused failure of the Diversion Channel levees and flooding of agricultural lands in the San Jacinto Gap region (Tetra Tech and WRIME 2007, Appendix A, p. 1) (USFWS, 2012).

**Stressor:** Alteration of hydrology (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitats that support Atriplex coronata var. notatior are vulnerable to alteration of the supporting watershed, including prolonged inundation from increases in urban run-off as well as drainage of wetlands from removal of water supply (USFWS 1998, pp. 54984–54985). These alterations of hydrological processes are often the result of agriculture or urban development activities adjacent to alkaline wetlands. The San Jacinto River floodplain is often dry due to groundwater infiltration enhanced by low groundwater levels from excessive pumping and limited recharge (Tetra Tech and WRIME 2007, p. 28), which alter the seasonal flooding cycle. The Upper Salt Creek occurrence is bisected north to south by the San Diego Aqueduct Canal and currently includes open fields and cow pastures within the remaining alkaline vernal pool, alkaline grassland, and alkali scrub habitats (RECON 1995, pp. 15, 17; CNDDB 2012, EO 9). Additionally, historical drainage patterns in the Upper Salt Creek occurrence are disrupted by local roads, road ditches, and agricultural drainage ditches, which have reduced the degree and duration of ponding during the wet season (RECON 1995, p. 18) (USFWS, 2012).

**Stressor:** Disking (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** More than 500 ac (200 ha) of occupied or potential habitat for Atriplex coronata var. notatior has been disked for the purposes of fire suppression or weed abatement (USFWS 1998, p. 54984, citing Roberts 1993, p. 2). Disking (or tilling) is also used to prepare areas for farming activities. This activity changes the microtopography of the natural floodplains and the alkaline soils themselves, both of which are important features for establishment of this taxa and other native plants found in these seasonally flooded habitats (Bramlet 2009, pers. comm.). Disking for dryland farming has been an ongoing activity in the San Jacinto River floodplain for perhaps 100 years; however, this activity was, in the past, intermittent, allowing for recovery periods for Atriplex coronata var. notatior during fallow periods (Roberts 1999, pers. comm.) (USFWS, 2012).

**Stressor:** Invasive nonnative plants (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Displacement of Atriplex coronata var. notatior by nonnative plants was identified as a threat at the time of listing. In particular, the expansion of a nonnative grass, Crypsis schoenoides (swamp prickle grass), was described as an important threat as a result of its seeding as a food source for migratory waterfowl along the San Jacinto River (USFWS 1998, p. 54988). establishment of nonnative plants such as Brassica nigra (black mustard) and Salsola traga (Russian thistle) as a result of manure and sludge dumping along the Lower San Jacinto River floodplain has been documented (USFWS 2008, pp. 15–16). The continued planting of cover crops such as Festuca perennis (rye grass) (as Lolium multiflorum (Italian rye grass)) or Festuca (as Lolium) rigidum (Wimmera ryegrass; rigid Italian rye grass) for waterfowl, competes with existing alkali plant communities (Bramlet 2009, pers. comm.), displacing Atriplex coronata var. notatior and other native plants. The prevalence of nonnative plants remains a threat to Atriplex coronata var. notatior due to continued disturbance of these areas and the proximity of A. c. var. notatior occurrences to consistent sources of nonnative species of grasses and forbs from nearby residential development and highways (USFWS, 2012).

**Stressor:** Sheep grazing (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, intensive sheep grazing was described for the San Jacinto River and Hemet floodplain areas occupied by Atriplex coronata var. notatior (USFWS 1998, p. 54985). Sheep grazing in habitat occupied by A. c. var. notatior in the Upper Salt Creek occurrence was reported in 2005 (Roberts 2005, pers. comm.). Grazing is a recurring threat to the taxon at the Upper Salt Creek and the Lower San Jacinto River occurrences (USFWS, 2012).

**Stressor:** Trampling (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Sheep grazing has been previously described as the primary impact related to trampling to individual stands of plants. Trampling resulting from off-road vehicle use is likely to be a localized, individual threat to some populations of Atriplex coronata var. notatior within the most southern portion of the Lower San Jacinto River occurrence based on visible off-road trails and land disturbance observed with aerial imagery (ESRI 2010) (USFWS, 2012).

**Stressor:** Climate change (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Projected effects of climate change in the southwestern California ecoregion occupied by Atriplex coronata var. notatior from regional climate models indicate a mean annual temperature increase of 1.7 to 2.2º Celsius (C) (3.06 to 3.96º Fahrenheit (F)) by 2070, and a general consensus of a 2º C (3.6º F) increase in most months over the next 100 years (Point Reyes Bird Observatory [PRBO] Conservation Science 2011, p. 40). Vegetation changes are also expected. Drier climatic conditions can increase the threat to taxon such as Atriplex coronata var. notatior that rely on seasonal rainfall (USFWS 1998, p. 54989). Although there is currently uncertainty with current model projections of precipitation in southern California, the Service believes that predictions of warmer temperatures and increased variability in extreme rain or flood events are a threat to A. c. var. notatior through resultant changes in precipitation patterns that create conditions essential for maintaining habitat that supports plant populations (USFWS, 2012).

***Recovery***

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

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

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- Survey all historical and extant occurrences to determine the location, status, and acreage of occupied and suitable habitat of each population to establish a comprehensive baseline against which to measure future changes. Surveys should be concentrated on the remaining Willows soil series within the basin and valley floors that form the U-shaped region surrounding the Lakeview Mountains, encompassing the San Jacinto River and Upper Salt Creek 100-year floodplains. Additionally, a more focused survey for Atriplex coronata var. notatior should be conducted within the Alberhill Creek floodplain during a year with above average rainfall (USFWS, 2012).
- Conserve or preserve Atriplex coronata var. notatior occurrences on private lands. Continue to identify key property easements or parcels in the San Jacinto and Upper Salt Creek floodplains for Partners for Fish and Wildlife programs or purchase through the Act’s section 6 funding program (USFWS, 2012).
- Manage Atriplex coronata var. notatior occurrences to prevent potential impacts from recreational activities, dumping, or other human-related activities. This may include fencing or posting to prevent access to managed areas and evaluation of appropriate use of disking

practices for fire suppression and weed abatement (USFWS, 2012).
- Engage in the State of California’s TMDL program to ensure that water quality (as discussed in FACTOR A and FACTOR D) within habitat occupied by sensitive taxon, such as Atriplex coronata var. notatior, is evaluated in determining “beneficial uses” within the Temescal Creek (and its tributaries) and Lake Elsinore TMDL process (USFWS, 2012).
- Develop a Population Viability Analysis model such as a metapopulation occupancy model for Atriplex coronata var. notatior to determine the key features for survival. Conduct a sensitivity analysis to identify those elements that represent the most important threats to maintaining minimum population size (USFWS, 2012).
- Conduct research to evaluate reproductive life history characteristics such as seed germination requirements, mechanism of seed dispersal, and seed viability. This will assist in identifying reasons for the persistence of certain occurrences and actions needed to help conserve others (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Atriplex coronata var. notatior and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Survey all historical and extant occurrences during the late spring-early summer subsequent to rainy seasons featuring average to above-average annual precipitation. This will help to determine the location, status, and acreage of occupied and suitable habitat of each population to establish a comprehensive baseline against which to measure future changes. Surveys should be concentrated on the remaining Willows, Traver, Domino, Chino, Waukena, Grangeville saline-alkaline, and Buchenau soil series within the basin and valley floors that form the U-shaped region surrounding the Lakeview Mountains, encompassing the San Jacinto River and Upper Salt Creek 100-year floodplains. Additionally, a more focused survey for A. c. var. notatior should be conducted within the Alberhill Creek floodplain during a year with above average rainfall. 2. Preserve A. c. var. notatior occurrences on private lands. Continue to identify key property easements or parcels in the San Jacinto and Upper Salt Creek floodplains for Partners for Fish and Wildlife programs or purchase through the Act’s Section 6 funding program. 3. Conduct research to understand important life history characteristics such as confirming the breeding system, seed germination requirements, mechanism of seed dispersal, and seed viability that will assist in identifying the underlying reasons for the persistence of certain occurrences and actions needed to help conserve others. 4. Develop an approach for restoring degraded alkali vernal pool and alkali meadow habitat suitable for reintroducing the species including: conducting a genetic study throughout the species range to inform seed collection efforts; collect and bank seed, develop a GIS-based habitat suitability model to determine appropriate areas for restoration, and model the species hydrological needs. 5. Manage A. c. var. notatior occurrences to prevent potential impacts from recreational activities, dairy waste deposition, or other human-related activities. This may include fencing or posting to prevent access to managed areas and evaluation of appropriate use and timing of discing practices for fire suppression and weed abatement. 6. Conduct research to understand the magnitude of the impacts associated with nonnative plant competition and develop appropriate techniques for managing nonnative plant species, where appropriate. In particular, determine the effects of Oncosiphon pilulifer, Hordeum murinum, and Hordeum marinum on A. c. var. notatior recruitment and persistence. Research appropriate timing and techniques to control the two nonnative barley species and O. pilulifer while minimizing impacts to A. c. var. notatior and the two, co-occuring native dwarf barley species (Hordeum intercedens and H. depressum). 7. Develop a Population Viability Analysis model such as a metapopulation occupancy model for A. c. var. notatior to determine the key features for survival. Conduct a sensitivity analysis to identify those elements that represent the most important threats to maintaining minimum population size. (USFWS, 2021)

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Revised Designation of Critical Habitat for Allium munzii (Munz's Onion) and Atriplex coronata var. notatior (San Jacinto Valley Crownscale)r. Final rule. 78 FR 22626-22658 (April 16, 2013)

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# SPECIES ACCOUNT: *Ayenia limitaris* (Texas ayenia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/23/1994; Southwest Region (R2)

**Physical Description**

A spineless shrub with a canopy reaching up to 2.0 meters (m) (6.6 feet [ft]) in height and 2.8 m (9.2 ft) in breadth. However, mature, reproductive plants may be as little as 0.3 m (1.0 ft) tall and broad. The alternate, soft, heart-shaped leaves have minute hairs and toothed margins; microscopically, the hairs on the lower surfaces of the leaves are stellate. The older, woody stems are reddish-brown, up to 2 centimeters (cm) (0.8 inches [in]) thick, and dotted with cream-colored lenticels. Inflorescences arise from the leaf axils, from 1 to 4 per node; the peduncles are about 1 cm (0.4 in) long, usually bearing 3 flowers on pedicels up to 1 cm (0.4 in) long. The flowers are about 6 millimeters (mm) (0.24 in) wide, with five greenish, 3 mm- (0.12 in-) long sepals and 5 yellow- to cream-colored, kidney-shaped petals (having two prominent, ovate lobes) bearing filamentous claws. The fruit, a five-chambered capsule up to 1 cm (0.4 in) in diameter before drying, is covered with curved, velcro-like appendages that may adhere to the hair of animals. Capsules produce up to 5 dark brown to black, tuberculate seeds 4 to 5 mm (0.16 to 0.20 in) in length. The maturing capsules turn from green to straw-colored; eventually the 5 chambers split apart, ejecting the seeds up to about 3 m (10 ft) from the parent plant. (USFWS, 2016)

**Taxonomy**

Tamaulipan kidneypetal was first collected by C.G. Pringle (Pringle no. 2272) in 1888 in the vicinity of Hidalgo, Texas. This collection was initially identified as Ayenia berlandieri S. Watson; the genus Ayenia was classified at that time in the Sterculiaceae (cacao family). Robinson and Greenman (1896) based their description of a new species, Nephropetalum pringlei B.L. Rob. & Greenm., on Pringle’s specimen. Tamaulipan kidneypetal was collected several times in Cameron County, Texas, between 1924 and 1955 (see Table 3), and identified as A. berlandieri. Cristóbal (1960) first described the species limitaris, based on Shiller’s 1955 specimen from Brownsville, in her monograph on the genus Ayenia, which she also placed in the Sterculiaceae; this continues to be the authoritative treatment of the genus (Tropicos 2009). Both A. limitaris and N. pringlei were recognized as valid species until Dorr and Barnett (1986) established their synonymy. The name A. limitaris was retained, since Cristóbal had already described another species as A. pringlei Cristóbal. (USFWS, 2016)

**Historical Range**

In Texas, in Cameron, Hidalgo, and Willacy counties; also northeast Mexico. (USFWS, 2016)

**Current Range**

In Texas, in Cameron, Hidalgo, and Willacy counties, and northeast Mexico. (USFWS, 2016)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination, based on closely related species (USFWS, 2016)

**Lifespan**

Adult: Unknown; propagated plants: 10+ years (USFWS, 2016)

**Breeding Season**

Adult: May - June, September - November: bimodal (USFWS, 2016)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2010); direct sunlight, rainfall (USFWS, 2016)

**Reproduction Narrative**

Adult: A. limitaris is effectively pollinated by a locally abundant insect of the Rio Grande delta (USFWS, 2010). It appears to require at least some direct sunlight for successful reproduction. Herbarium specimens and observations of Tamaulipan kidneypetal in Texas indicate that wild plants flower most often in June, July, September, October, and November. The more consistent and prolific flowering and fruiting lasts from September through November; flowers and capsules may also be observed from May to June following significant rainfall. This pattern coincides with the prevailing bimodal rainfall pattern in the Rio Grande delta. During seasons when there has been little or no precipitation, Tamaulipan kidneypetal plants do not flower. Therefore, reproduction appears to be stimulated primarily by rainfall. Most members of the genus Ayenia, including A. limitaris, are obligately allogamous; their floral morphology renders self-fertilization mechanically impossible (Cristóbal 1960). The longevity of individual Tamaulipan kidneypetal plants is unknown. However, propagated plants in experimental plots and reintroduction sites have lived at least 10 years without any apparent decline in vigor. These plants began flowering and producing viable seed at about 1 to 2 years of age (USFWS, 2016).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical woodland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Partial shade (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: Inland aridity, freezing temperatures, high elevations (USFWS, 2014)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2014)

**Habitat Narrative**

Adult: Dense subtropical woodland communities at low elevations. The current Texas site is within the Texas Ebony-Anacua (Pithecellobium ebano-Ehretia anacua) plant community - a closed-canopy community of riparian terraces that once covered much of the Rio Grande delta, but is now reduced to remnant fragments surrounded by agricultural fields, pastures, and urban areas. The site was once an active floodplain, and the effects of hydrologic changes on Ayenia limitaris are unknown (NatureServe, 2015). Wild populations have now been documented in a wide range of alluvial soil types, from fine sandy loam to heavy clay. The species establishes well and reproduces rapidly in disturbed soils. Wild populations frequently occur in partial shade, or at the edge of shrub canopies, rather than under dense shrub or forest canopies (USFWS, 2010). The species' range appears to be restricted by increasing aridity further inland and by the prevalence of freezing weather further north and at higher elevations in the mountain ranges of northeast Mexico (USFWS, 2016).

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: The capsules dehisce upon drying, scattering the seeds up to a few meters away from the parent plant. The recurved appendages of the fruit capsule may also serve to disperse entire capsules by adhering to animal hair or feathers. Additional seed dispersal may be caused by insects, water flow, or other factors (USFWS, 2010).

***Population Information and Trends***

**Population Trends:**

Declining (inferred from USFWS, 2016)

**Number of Populations:**

U.S.: 5; Mexico: 10 (USFWS, 2016)

**Population Size:**

U.S.: 1,400 - 1,800; Mexico: 4,000+ (USFWS, 2010)

**Minimum Viable Population Size:**

250 mature plants (USFWS, 2016)

**Population Narrative:**

Five extant populations, ranging from about 100 to 1,000 individuals, have been documented in the three southernmost counties of Texas. Ten extant populations, totaling at least 4,000 individuals, occur in two municipios of the Mexican State of Tamaulipas. At least seven populations in Texas have been extirpated. One population reported from Coahuila, Mexico has not been seen since 1936. A specimen was collected in 1985 in Topia, Durango, Mexico, but the species has not subsequently been reported from that area. (USFWS, 2016)

***Threats and Stressors***

**Stressor:** Habitat fragmentation and isolation (USFWS, 2016)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Fragmentation and isolation may prevent gene flow among populations and lead to a depletion of genetic diversity. Cristóbal (1960) stated that Ayenia species are allogamous and insectpollinated. Therefore, viable populations of Tamaulipan kidneypetal must be large enough to contain sufficient genetic diversity for out-crossing to occur, and habitats must be sufficiently large and diverse to sustain populations of the insect pollinators. The remaining habitats throughout the species' known range are greatly fragmented, and remaining populations are isolated from each other. Since the genetic diversity within and among populations has not been investigated, we do not know to what extent genetic depletion may have occurred or how soon it could occur. Currently, the known populations continue to reproduce successfully. In synthesis, we consider that habitat fragmentation and isolation and the resulting depletion of genetic diversity are real threats of unknown magnitude and immediacy. However, if not addressed, these are likely to become high magnitude, imminent threats. Furthermore, once genetic diversity has been lost it cannot be recovered. Therefore, the recovery actions that mitigate these threats should not be delayed. (USFWS, 2016)

**Stressor:** Ungulate browsing (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Ungulate browsing. Contreras-Arquieta (2005) observed several Tamaulipan kidneypetal sites in the municipio of Soto la Marina, Tamaulipas, that were used as goat pasture. He included goat browsing as a potential threat to the species. Although we have no information on the palatability of Tamaulipan kidneypetal to livestock, or the impacts of grazing on its populations and habitat, it is important to note that the largest U.S. population, and most if not all Mexican populations, occur on land that has been grazed by cattle. We conclude that cattle grazing is not a threat to the species and that goat browsing is an imminent but low-magnitude threat. Browsing by white-tailed deer (Odocoileus virginiana) may also constitute a threat where deer populations are high. (USFWS, 2016)

**Stressor:** Climate change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** We do not know how past climate changes have affected Tamaulipan kidneypetal populations and distribution, nor can we predict how future climate changes, forecast by the range of models and emissions scenarios, will affect the synecology of the species and its habitat. For example, a reduced amount or frequency of rainfall could reduce the species' range, while a decreased incidence of freezing could expand its range northward or into higher elevations in Mexican mountains. Furthermore, if the optimal geographic range of Tamaulipan kidneypetal shifts, the species may not be able to migrate fast enough to keep up with the rapid pace of climate changes. Conditions favorable to Tamaulipan kidneypetal might also increase competition from invasive plants, such as guineagrass, or allow new parasites and pathogens to spread into its range, affecting both Tamaulipan kidneypetal and guineagrass in an infinitely complex aggregation of interacting effects. Consequently, we currently have no evidence that the combined effects of climate changes threaten Tamaulipan kidneypetal. However, it is possible that threats induced by climate changes, based on predicted slight increases in temperature and

evaporative deficit, may arise in the future. (USFWS, 2016)

**Stressor:** Competition from introduced invasive grasses (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Several introduced grass species of African and Asian origin are invasive throughout the Tamaulipan region of Texas and northeast Mexico, and have replaced much of the herbaceous plant diversity. In particular, guineagrass has been recorded at most Tamaulipan kidneypetal sites in Texas, and is probably present at all sites in Texas and Tamaulipas. Guineagrass competes directly with Tamaulipan kidneypetal for the same partially-shaded niches. Buffelgrass, King Ranch bluestem (Bothriochloa ischaemum), and Angleton bluestem (Dichanthium aristatum) were also listed as threats in the listing (USFWS 1994). Buffelgrass is extremely abundant throughout the region, and is a major threat to many rare plant species. Although buffelgrass is not shade-tolerant, it might exclude Tamaulipan kidneypetal from the more open portions of the habitat. Tamaulipan kidneypetal is probably threatened more by Kleberg bluestem and Angleton bluestem than by King Ranch bluestem. The former two grass species are abundant in alluvial, fine-textured soils in the deltas and flood plains of south Texas and northeast Mexico. The latter species prevails in well-drained, rocky uplands, such as the Edwards Plateau of central Texas. These three closely-related taxa pertain to a species complex often generically referred to as Old World bluestems; they are difficult to distinguish in the field and are often confused. Other invasive plants, such as introduced Kalanchöe species, may also threaten Tamaulipan kidneypetal in some sites. In summary, competition from introduced invasive grasses is a high-magnitude, imminent threat to all known populations of Tamaulipan kidneypetal. (USFWS, 2016)

**Stressor:** Loss of pollinators (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, flowers of Tamaulipan kidneypetal plants are effectively fertilized by unknown insect pollinators even when isolated from wild populations. This indicates that suitable pollinators are widespread and abundant in the region. Nevertheless, insect pollinators could be depleted, and pollinator access could be disrupted, by the loss and fragmentation of habitats, pesticide drift, or depletion of the native plant diversity. Pollinator loss is currently not a known, imminent threat, but could become a threat in the future. Several recovery actions included in this plan will help prevent the loss of Tamaulipan kidneypetal pollinators. (USFWS, 2016)

**Stressor:** Catastrophic events (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since there are few populations, most populations have few individuals, and populations are confined to limited geographic areas, individual populations are vulnerable to chance catastrophic events, such as hurricanes or the introduction of an invasive pathogen or parasite. However, due to the geographic range of known populations, it is unlikely that a single event could impact all populations. We conclude that catastrophic events represent a low-magnitude, non-imminent threat. (USFWS, 2016)

**Stressor:** Pesticide drift and runoff (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This potential threat has not been observed. However, due to the fragmentation and small size of occupied habitats and their proximity to agricultural fields and highway rights-of-way, herbicide and insecticide drift and chemical spills could harm some populations or the pollinators they depend on. Nevertheless, it is unlikely that accidental herbicide contamination will impact significant numbers of Tamaulipan kidneypetal plants. This low-magnitude, non-imminent threat can be further reduced through outreach to owners and managers of Tamaulipan kidneypetal habitats. (USFWS, 2016)

**Stressor:** Trampling (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Foot traffic can damage individual plants that occur along trails in parks and natural areas, or where people illicitly traverse habitats off-trail. Ordinarily, people avoid walking through dense thickets of spiny shrubs. However, undocumented aliens entering the U.S. from Mexico often pass through stands of native vegetation to avoid detection, and have damaged vegetation in natural areas along the border. Nevertheless, little if any actual damage to Tamaulipan kidneypetal plants has been observed from trampling. Consequently, we do not consider trampling to be a threat to the species. (USFWS, 2016)

**Stressor:** Oil and gas development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In Texas, mineral rights owners take precedence over surface owners and may clear land for drilling operations without landowner consent. Many surface landowners in south Texas, including most federal and state conservation agencies and non-governmental conservation organizations, do not own mineral rights. Similarly, mineral rights in Mexico are owned by the Mexican federal government rather than the surface owner. Oil and gas exploration and extraction continues at a rapid pace throughout much of south Texas and northeast Mexico, and an ever-increasing proportion of the land has or will be cleared for drilling platforms, pipelines, access roads, and related infrastructure. In addition to the direct loss of populations and habitat through land clearing, these operations will increase the fragmentation of habitat and will create new colonization pathways for invasive grasses. Tamaulipan kidneypetal populations on private lands are particularly vulnerable, since the U.S. ESA does not protect endangered plants on private lands unless there is another form of prevailing federal nexus, such as a federally-funded program or regulated action. Therefore, oil and gas development is an imminent threat; the magnitude is medium to high, depending on the duration and intensity of hydrocarbon exploration that in turn is dependent on economic factors and the intricacies of energy markets. (USFWS, 2016)

**Stressor:** Altered vegetation structure and composition (USFWS, 2016)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Many ecologists believe that grasslands and savannas were more abundant in south Texas and northeast Mexico prior to European settlement, and that these vegetation types were converted to dense shrubland and forest as a consequence of poor rangeland management and changes in the natural fire cycle (see discussion in section I.d.-Ecology). This dramatic shift in vegetation composition and structure and fire dynamics may also have contributed to the decline of Tamaulipan kidneypetal. (USFWS, 2016)

**Stressor:** Unintended impacts of propagation and reintroduction (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The recovery actions proposed under the 2016 Recovery Plan include propagation and reintroduction of Tamaulipan kidneypetal into suitable habitats. These actions could cause unintended harm to the species, such as depletion of the seed banks of wild populations, genetic swamping due to excessive propagation from a genetically limited source population, inbreeding depression, outbreeding depression, and the spread of pathogens or parasites into healthy populations. Pilot reintroduction efforts conducted at LRGV NWR in the 1990s preceded the adoption, in 2000, of the USFWS policy on controlled propagation of endangered species (USFWS and NMFS 2000). This policy now requires that the potential risks of propagation be assessed and addressed prior to initiating propagation by USFWS or through USFWS support. Section E.13 of the policy requires preparation of a controlled propagation and reintroduction plan prior to the reintroduction of federally-listed threatened or endangered species. The plan should be based on strategies identified in an approved recovery plan, and should include protocols for health management, disease screening and disease-free certification, monitoring and evaluation of genetic, demographic, life-history, phenotypic, and behavioral characteristics, data collection, recordkeeping, and reporting, as appropriate. We conclude that, through compliance with USFWS policy on propagation and reintroduction, these actions will not threaten the species. (USFWS, 2016)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Tamaulipan kidneypetal is not protected by other U.S. federal or state laws. Federally-listed plants occurring on private lands have limited protection under the ESA, unless also protected by state laws; the State of Texas provides very little protection to listed plant species on private lands. Approximately 95 percent of Texas land area is privately owned. It is reasonable to assume that the vast majority of existing Tamaulipan kidneypetal habitat, including sites that have not been documented, occurs on private land. Therefore, most of the species' populations and habitats are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project. (USFWS, 2016)

***Recovery***

**Reclassification Criteria:**

1. The successful accomplishment of threats reduction and mitigation is demonstrated by a stable or improving status of Tamaulipan kidneypetal, compared to the baseline conditions, throughout its known range over a period of at least 10 years. (Threat-based objective) (USFWS, 2016)

2: At least 10 populations of Tamaulipan kidneypetal, and at least 1 per recovery unit, are documented in optimal habitats for a period of at least 10 years. Habitat is considered optimal when: It is protected for conservation purposes; it is managed in a manner that promotes the long-term survival of Tamaulipan kidneypetal; it has less than 10% cover of introduced invasive plant species; it consists of at least 400 ha (988 ac) of contiguous habitat; and where Tamaulipan kidneypetal populations are observed to be stable or increasing. (Habitat-based objective) (USFWS, 2016)

3. Conserve, protect, and restore populations of Tamaulipan kidneypetal needed for its recovery. Populations must be self-sustaining, of sufficient size to endure climatic variation and stochastic events, of sufficient number to endure catastrophic losses, and must represent the full range of the species' geographic and genetic variability. (Population-based objective) (USFWS, 2016)

Recovery Priority Number: 8C

**Delisting Criteria:**
Criteria 1 through 3: Same as Downlisting Criteria (USFWS, 2016)

4: Twenty (20) or more protected populations, including no less than 5 per recovery unit, have maintained stable or increasing populations of at least 500 mature individuals, 47 and at least 1 population per recovery unit maintains 1,000 or more individuals, for a total of at least 20 years. (USFWS, 2016)

**Recovery Actions:**
- 1. Protect and conserve the known populations and their habitats in the U.S. and Mexico. Promote cooperative efforts to conserve occupied habitats and protect known populations from invasive grass competition, excessive browsing, trampling, and other potential threats. Seek sources of financial and technical assistance to support these efforts. This action faces the following challenges: 1) Several known populations in the U.S. occur on private land; 2) a majority of the known populations, and almost all of the species' global range, occur in Mexico; 3) the known Mexican populations all occur on private or ejido land. Consequently, the U.S. ESA confers no authority to enforce the degree of population and habitat protection that is necessary to prevent a significant decline (jeopardy) of the species. Therefore, this action must rely heavily on voluntary conservation efforts and on close collaboration with Mexican agencies and conservation organizations. Furthermore, since it is probable that some populations on private and ejido lands will be destroyed or deteriorated through urban and agricultural development or other causes, this action addresses an objective of no net loss of populations and habitats; losses and deterioration of some populations and habitats may be offset through successful habitat restoration, improved management and protection of existing occupied habitat, or the discovery of new occupied habitats. (Priority 1) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)

- 2. Develop a monitoring plan, and monitor known populations and habitats. The objectives and requirements of the monitoring plan are discussed in II.1 of the 2016 Recovery Plan. Visit known populations at least once per year, if possible, to make qualitative observations of habitat conditions and the growth and reproduction of Tamaulipan kidneypetal. Determine if there are any new or existing threats to the population and recommend actions to alleviate threats. Collect quantitative data on population size and reproduction at least 5 times every 10 years to track long-term population dynamics. (Priority 1)[More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 3. Develop partnerships with Mexican government agencies, academic institutions, and NGOs to promote investigation, conservation, and recovery of the species in Mexico. Potential Mexican agency partners include the Secretaría de Desarrollo Urbano y Medio Ambiente (Secretary of Urban Development and Environment, State Government of Tamaulipas; SEDUMA) and SEMARNAT, CONANP, and CONABIO (federal). Academic institutions may include Universidad Autónoma de Tamaulipas, Universidad Autónoma de Nuevo León (particularly the Facultad de Ciencias Forestales [Forestry Sciences Department]), and the Instituto Tecnológico y de Estudios Superiores de Monterrey (Monterrey Institute for Technology and Advanced Studies; ITESM). Pronatura Noreste a.c., based in Monterrey, Nuevo León, is a potential NGO partner. (Priority 1) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 4. Improve management of known populations and habitats, based on monitoring data and the conclusions of scientific investigations (adaptive management). (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 5. Conduct public outreach in the U.S. and Mexico to promote the species' conservation and recovery. Disseminate outreach materials, attend public meetings, communicate with interested members of the public, and meet interested landowners to discuss conservation and recovery of Tamaulipan kidneypetal. (Priority 2) [More details are available in the 2016 Recovery Plan.] (USFWS, 2016)
- 6. Conduct scientific investigations necessary for conservation and recovery. (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 7. Search for new and historic populations in U.S. and Mexico. Seek permissions from public, private, and ejido landowners to conduct surveys in areas of intact habitat where the climate, soils, and vegetation are similar to known and historic populations. (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 8. Restore and subsequently manage native vegetation within the Rio Grande delta recovery units to increase the amount of suitable available habitat and to establish functioning ecological corridors that reconnect isolated habitat fragments. Restoration methods must use local ecotypes of native species, and must restore a diverse sub-shrub, native grass, and forb understory and a partially open tree and shrub canopy to be considered suitable for Tamaulipan kidneypetal. Effective habitat restoration will offset unpreventable losses of habitat on private lands, and will make the criterion of no net habitat loss more achievable and practical. (Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 9. Augment and reintroduce populations in appropriate habitats within the known range in U.S. and Mexico. Augmentation is the supplementation of an existing population with progeny of the same population or another population that is genetically suitable. Reintroduction is the establishment of new populations within the species' known range and habitat types, but where a population currently does not exist. The objective in either

case is to attain the criteria of an MVP of 250 or more mature individuals per population, 5 or more populations per recovery unit, at least 1 population per recovery unit with 1,000 or more mature individuals, and a minimum of 20 populations overall. All propagation and reintroduction will conform to the guidelines stipulated in an established controlled propagation and reintroduction plan.(Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)

- 10. Prepare post-delisting monitoring plan. In accordance with ESA section 4(g)(1), upon recovery and removal from the endangered species list, the status of delisted species must be monitored for not less than five years. In consideration of the potential responses of 59 Tamaulipan kidneypetal populations, based on its lifespan, reproductive rate, and demography, to the removal of federal protection, monitoring should be continued for at least 10 years to ensure that the populations and criteria upon which delisting are based continue to be secure. Post-delisting monitoring must quantitatively document the extant populations upon which delisting is based, including population sizes, age structures, reproduction, recruitment and mortality, habitat conditions, invasive species impacts, degree and effectiveness of protection, and impacts of threats. (Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- Complete an approved recovery plan for the species (USFWS, 2010).
- Continue periodic monitoring and surveys of the known populations in Texas and Tamaulipas to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2010).
- Conduct surveys of high-potential habitat within the known range of the species in south Texas and Tamaulipas, focusing on sites that have not previously been surveyed (USFWS, 2010).
- Survey existing habitats in the municipios of Múzquiz, Coahuila and Topia, Durango to attempt to confirm extant populations at those sites (USFWS, 2010).
- Collect seeds from the known populations and implement a reintroduction program at LRGV NWR, in accordance with USFWS policy on controlled propagation of endangered species (65 FR 56916) (USFWS, 2010).
- Conduct scientific investigations of the species’ reproductive biology, the genetic structure of known populations, and the genetic relationship between Ayenia limitaris and closely related species (USFWS, 2010).
- Conduct scientific investigation of the species’ ecology, with emphasis on vegetation structure and fire ecology (USFWS, 2010).
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Follow recommended actions outlined by the 2016 Texas Ayenia Recovery Plan. • Continue periodic monitoring and survey of the known populations in Texas and Tamaulipas Mexico to track demographic trends, and to detect and attempt to alleviate threats to these populations • Conduct surveys of high-potential habitat within the known range of the species in south Texas and Tamaulipas Mexico, focusing on sites that have not previously been surveyed. • Survey existing habitats in the identified areas in Tamaulipas Mexico to attempt to confirm extant populations at those sites. • Collect seeds from the known populations and implement a reintroduction program at Lower Rio Grande Valley National Wildlife Refuge, in accordance with Service policy on controlled propagation of endangered species (65 FR 56916). •

Conduct scientific investigations of the species’ reproductive biology, the genetic structure of known populations, and the genetic relationship between Ayenia limitaris and closely related species. • Conduct scientific investigation of the species’ ecology, with emphasis on vegetation structure and fire ecology. • Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group (USFWS, 2022).

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# SPECIES ACCOUNT: *Baccharis vanessae* (Encinitas baccharis)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/7/1996; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A shrub, < 2 m tall, broom-like in appearance with dense, erect branches, often leafless when the plants are in flower. Leaves are linear. Herbage is generally sticky-resinous. Whitish flower heads, lacking rays, bloom in the fall (August-November), Male and female flowers are borne on separate plants (NatureServe, 2015).

**Taxonomy**

A member of the Asteraceae (sunflower family) (USFWS, 2011).

**Historical Range**

Endemic to a narrow band of central-coastal San Diego County, California, from Encinitas eastward to Woodson Mountain, near Poway and southward to Mira Mesa; an area of ca 30 km E-W by 17 km N-S. Reported from 45 historical occurrences distributed within the same general range as that known at the time of listing, except for a southward extension of the range based on an occurrence detected in the Otay Mountain area. (NatureServe, 2015).

**Current Range**

This species is restricted to a patchy distribution along the coast and occasionally interior areas of San Diego County, California (USFWS, 2011).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Sexual: cross-pollination (USFWS, 2012)

**Lifespan**

<u>Adult:</u> Presumed long-lived (NatureServe, 2015)

**Breeding Season**

<u>Adult:</u> August - November (USFWS, 2011)

**Key Resources Needed for Breeding**

<u>Adult:</u> Wind, insect pollinators (USFWS, 2011)

**Reproduction Narrative**

<u>Adult:</u> The blooming period is between August and November (CNPS 2010; San Diego Plant Atlas 2010). Baccharis vanessae is dioecious, meaning separate plants of both sexes must be in close

proximity for pollination and subsequent seed production to occur. Pollinated Baccharis flowers develop one-seeded dry fruits (achenes). Baccharis vanessae is probably pollinated by both wind and insects. Steffan (1997, pp. 52–54) collected native wasps, flies, beetles, and true bugs (from the order Hemiptera) from Baccharis pilularis (coyote bush), a related species that has flowers similar to B. vanessae and which also occurs in the same chaparral habitat. It exhibits an apparently low incidence of successful seedling establishment (USFWS, 2011). This species is presumed to be long-lived (NatureServe, 2015).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Maritime chaparral, mixed chaparral (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Disturbance/fire (USFWS, 2011)

**Geographic or Habitat Restraints or Barriers**

Adult: 60 - 335 m elevation (NatureServe, 2015), tall leafy shrubs (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2011)

**Habitat Narrative**

Adult: Occupies steep slopes on sandstone and volcanic (1 site) substrates in fairly open southern maritime chaparral and dense mixed chaparral communities. Occurs at 60 - 335 m elevation (NatureServe, 2015). Observations suggest that Baccharis vanessae is not able to compete with taller, leafier shrubs such as Arctostaphylos spp. (manazanita) and Ceanothus spp., (ceanothus) or that it is a short-lived plant (KEA 1999, p. 15). Baccharis vanessae appears to be a pioneer species that increases in numbers after disturbance, such as fire, that opens up the chaparral canopy (Messina 2001, pp. 2–3; CNDDB 2011, EOs 17 and 18). Overall, B. vanessae appears to increase in numbers in burned areas following fire events. Baccharis vanessae has been observed to occur on the following soil types: Cieneba series, Corralitos loamy sand alluvial Huerhuero, San Miguel Exchequer, granitic, andesite rock outcrops, and soils derived from acid igneous rock (CNDDB 2011) (USFWS, 2011).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Achenes are each attached to a cluster of bristly hairs (a pappus), which facilitates wind dispersal (Steinberg 2002, p. 5). (USFWS, 2011).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Increasing (USFWS, 2011).

**Number of Populations:**
14 presumed extant (USFWS, 2021)

**Population Size:**
Unknown (USFWS, 2011)

**Adaptability:**
Low (inferred from USFWS, 2011)

**Population Narrative:**
The species is now presumed extant at 30 occurrences. accurate plant counts for B. vanessae do not exist because no rangewide surveys have been conducted using a single monitoring protocol. Life history traits and habitat specificity seem to comprise the most significant vulnerabilities of Baccharis vanessae. The number of occurrences currently considered extant increased from 16 to 30 since listing (USFWS, 2011). Our 2011 5-year review identified 45 occurrences of Baccharis vanessae. 30 were extant or presumed extant and 15 were extirpated or possibly extirpated. Our review of new information from the CNDDB and the SDMMP found that there are 45 occurrences of B. vanessae. Fifteen are extant, 14 are presumed extant, 10 are possibly extirpated, and 5 are extirpated, although the organization of the occurrences is different than the 2011 5-year review (Table 1, Figure 1, and Figure 2). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Following listing, occurrences continued to be impacted by development. A portion of one occurrence in Rancho Cielo (CNDDB 2011 EO 7 that currently includes EOs 11, 13, and 14) was eliminated by urban development. development remains a threat to B. vanessae occurrences or portions of those occurrences as well as occurrences identified as REGSS points not encompassed by a CNDDB polygons or the quarter-mile buffer zone around them. Of the 30 extant occurrences, 11 continue to be threatened by development associated impacts (EOs 1, 3, 5, 7, 8, 9, 24, 25, 27, 31, and SD 115244) (USFWS, 2011).

**Stressor:** Altered fire regime (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In southern California, populated areas in proximity to natural vegetation often are under some form of fuel modification requirements. Fuel modification generally includes the clearing or thinning of fire prone natural vegetation, which would include that occupied by B. vanessae. Historically, natural fire regimes in southern California were likely characterized by many small lightning ignited fires in the summer and a few large fires in the fall of varying fire intensity (Keeley and Fotheringham (2003, pp. 242–243). The current fire regime in southern California results in numerous small fires that periodically escalate into megafires that are

generally driven by extreme "Santa Ana" weather conditions of high temperatures, low humidity, and strong erratic winds (Keeley and Zedler 2009, p. 90). The primary difference between the current fire regime and historical fire regimes in southern California is that human-induced or anthropogenic ignitions have increased primarily due to an increase in human population density since 1960, resulting in human-triggered fire ignitions and in particular, megafires in many more localities (Keeley and Fotheringham 2003, p. 240), than were known historically. The primary concern with frequent megafires is the plant mortality associated with these extensive and intense events which may kill individual plants and thereby potentially precludes recolonization of burned areas by B. vanessae. The lack of habitat clearing brushfires, of adequate frequency and intensity, may pose a threat to B. vanessae reproduction. The absence of an appropriate disturbance regime may also limit opportunities for recruitment of B. vanessae (USFWS, 2011).

**Stressor:** Nonnative plants (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Prevalence of nonnative plants is expected to increase with proximity to persistent sources such as residential development and highways. Nonnative plants may crowd out suitable establishment sites for B. vanessae, as may unchecked native plants, and they may alter the fire regime of the site. Carpobrotus edulis (iceplant, Hottentot fig) has the ability to invade maritime chaparral after brushfires (Zedler and Scheid 1988, pp. 196–201). The thick mat of this nonnative plant can prevent seedlings of native plants from becoming established (D'Antonio and Mahall 1991, pp. 886–888). Centaurea seeds are known to germinate much faster than those of some Baccharis species, grow rapidly during the winter and spring, and reduce the performance (biomass gain) of Baccharis seedlings (Gomez-Gonzalez et al. (2009, p. 81) (USFWS, 2011).

**Stressor:** Restricted distribution and small population size (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Baccharis vanessae is at risk of extinction from naturally occurring events because of its restricted distribution and small population size (USFWS 1996, p. 52381). The distribution of the species is relatively narrow and likely habitat limited. This situation may exacerbate any other threats that are rangewide in scope, such as wildfires or broad jurisdictional fire suppression efforts. The small size of many Baccharis vanessae populations increases the probability that those populations will disappear or be otherwise compromised through random fluctuations in the environment (such as severe droughts or fires), failure to be cross-pollinated, or random human caused events (such as the clearing of a parcel of southern maritime chaparral in northern Lux Canyon in 2009) (S. Vurbeff, City of Encinitas, pers. comm., 2010). Small populations are also more susceptible to the expression of deleterious genes (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The impacts of predicted climate changes on individuals and habitat of Baccharis vanessae and similar species are unknown at this time. Baccharis vanessae may already be suffering adverse effects from past climate changes resulting in a drier Holocene climate in

present-day southern California. The observed lack of B. vanessae seedlings could possibly indicate that this species is unable to survive the length, severity, or the current timing of the annual dry season in San Diego County. Williams and Hobbs (1989, pp. 62, 64–66) discovered that B. pilularis seedlings tend to survive only during rainy springs (March to May) brought on by rare mega-El Niños like the one in 1982 to 1983 because the seedlings' root growth is negligible prior to March (USFWS, 2011).

**Stressor:** Trampling (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, unauthorized camping occurs at Oak Crest Park in Encinitas (CNDDB 2011, EO 1) even though the area is conserved (Thiede, pers. obs., 2010). Visitor foot traffic, as well as potential trail maintenance activities, also pose a threat to the B. vanessae populations at EOs 17 and 18, and rock climbers at Woodson Mountain likely impact plants at EO 15 (CNDDB 2011) (USFWS, 2011).

***Recovery***

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

Recovery Priority Number: 5C

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

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- Survey all historical and extant occurrences to determine the location, status, age-class representation, and sex composition of each population to establish a comprehensive baseline against which to measure future changes. Survey all areas that support "maritime-like" southern mixed chaparral for additional occurrences (USFWS, 2011).
- Manage Baccharis vanessae occurrences to maintain plants of both sexes. Outplantings could be considered at occurrences such as EO 28 where only one plant has been observed (USFWS, 2011).
- Investigate the possible causes of seed mortality and low reproductive success, and identify likely remedies (USFWS, 2011).
- Conserve or preserve Baccharis vanessae occurrences on private lands. Property easements or purchases of parcels could also be made through the Act's section 6 funding and other programs (USFWS, 2011).
- Determine the appropriate use or substitute for a natural fire regime to perpetuate suitable habitat for Baccharis vanessae (USFWS, 2011).
- Determine which areas are most susceptible, to reduce impacts to Baccharis vanessae from fuel modification and fire suppression activities (i.e. using GIS analysis) (USFWS, 2011).
- Determine the distribution of genetic diversity in the species occurrences and identify the most appropriate means to preserve the diversity (USFWS, 2011).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Baccharis vanessae. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future recovery efforts. 1. Conduct surveys for B. vanessae, including 1) surveys of Regionally Sensitive Species (REGSS) points and CNDDB polygons on conserved land that are not monitored by the SDMMP or other partners, and 2) surveys of suitable habitat where the species has not been detected. 2. Support partners to enhance habitat and manage highest-magnitude threats at B. vanessae occurrences (for example, from nonnative invasive plants). 3. Coordinate with the SDMMP on the development of a Rare Plant Management Plan for B. vanessae, which includes species-specific best management practices and identifies research needs. Work with the SDMMP to prioritize research and management needs for B. vanessae. 4. Collect seed from B. vanessae occurrences and conserve in an ex situ (off-site) conservation seed bank. Coordinate with the SDMMP on the development of a Seed Banking and Bulking Plan for B. vanessae. (USFWS< 2021)

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# SPECIES ACCOUNT: *Baptisia arachnifera* (Hairy rattleweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/27/1978; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A perennial herb, 5-8 dm tall, that is covered with grayish-white cobwebby hairs. Leaves are heart-shaped. Flowers (late June-early August) are bright yellow, borne in terminal clusters. (NatureServe, 2015)

**Taxonomy**

Dr. Wilbur H. Duncan first collected the hairy rattleweed in the summer of 1942, and suspected that it was distinct from other Baptisia species which occur in the coastal plain of GA and FL. Subsequent collections in 1943 confirmed his suspicion (USFWS, 1984).

**Historical Range**

It is endemic to portions of Brantley and Wayne counties in southeastern GA (USFWS, 1984).

**Current Range**

Baptisia arachnifera only occurs in a 50-square mile area in Brantley and Wayne counties in Southeast Georgia, on the Lower Coastal Plain (Georgia Department of Natural Resources 1995). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (NatureServe, 2015); sexual (inferred from EPA, 2016)

**Dependency on Other Individuals or Species**

Adult: Insect pollinators, especially Say's weevil (EPA, 2016)

**Reproduction Narrative**

Adult: Capable of asexual reproduction if roots are cut (NatureServe, 2015). Flowering occurs June to August and fruiting occurs August to September. Pollinators are presumably insects. The weevil Apion rostrum Say (Say's weevil) is possibly a major pollinator (EPA, 2016). Humphrey (1987) estimated that 25% of plants reproduce and found the number of fruit per individual plant is highly variable, with a mean of 52 seeds per fruiting plant per year; therefore, the seed production per 100 plants has been estimated as 1300 (USFWS, 2011).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Longleaf pine-saw palmetto flatwoods (NatureServe, 2015); early successional forest (EPA, 2016)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fires (EPA, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: 55 - 85 ft. elevation (EPA, 2016)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow to moderate (inferred from EPA, 2016)

**Habitat Narrative**

Adult: This species naturally occurred in open sandy areas within longleaf pine-saw palmetto flatwoods. It is now persisting in intensively managed slash and loblolly pine plantations, powerline right-of-ways, roadsides and a few small natural areas. B. arachnifera can occur as widely scattered individual plants or in dense clusters. Research done by the Rayonier Corporation suggest that populations tend to be clumping (B. Krueger, written comm.) (NatureServe, 2015). Longleaf slash-pine flatwoods with sparse canopy, fewer larger shrubs, greater light penetration and greater cover of herbs (mainly wiregrass) and low shrubs of the Lower Coastal Plain of Georgia. Habitat has early successional characteristics of open canopy and low abundance of larger shrubs. Habitat includes mesic pine lowland forest or pine flatwoods. Also occurs in floristically similar but more open pine-wire grass (Aristida stricta) shrub woodlands with occasional oaks (Quercus laevis, Q. virginiana, Q. nigra). Fire adapted communities that would naturally burn every 2-4 years. Most abundant in communities with the early successional characteristics of open canopy and low abundance of larger shrubs. Often adjacent to/grades into pocosin or bay swamp habitats scrub-shrub wetlands toward the wetter end of spectrum to habitats typical of longleaf pine-turkey oak communities towards the drier end. Identified soils series include: Mascotte Sand, Rigdon Sand, Sapelo Fine Sand, Pottsburg Sand, and Olustee Sand. These are sandy to a depth of 3 ft or more and have spodic horizons within 20 inches of the surface. Acidic, low fertility. These soils are poorly drained to somewhat poorly drained and moderately permeable with Rigdon sand being the best drained. Runoff is slow and internal drainage is impeded by the shallow water table. Occurs at elevations between 55 to 85 ft. (known population sites) (EPA, 2016).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal occurs September to March; plants break off in wind and may disperse tumbleweed fashion with seeds still on the plant (EPA, 2016).

***Population Information and Trends***

**Population Trends:**

Declining (inferred from NatureServe, 2015)

**Species Trends:**

Declining (USFWS, 2011)

**Number of Populations:**

28 extant hairy rattleweed populations (USFWS, 2019)

**Population Narrative:**

Occurrences are scattered over a 125 square mile area. An estimated 95-99% of its original habitat has been converted to pine plantations (NatureServe, 2015). 22 extant populations occur entirely in Lower Coastal Plain of Georgia (EPA, 2016). The species status is declining; overstocking of trees, lack of fire management and seed predation by insects are the factors driving the species' decline. Ceska et al. (1997) found a substantial genetic diversity and relative uniformity in ten sampled plots (USFWS, 2011). Overall, there are 28 extant hairy rattleweed populations, 1 historical population, and 6 populations of unknown status (Figure 1). Only two populations, the Lewis Tract and Needmore Road, are apparently stable or increasing. The remaining 18 populations are likely declining due to incompatible silvicultural practices (e.g. bedding and timber harvesting). (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Silvicultural practices in the timber industry have altered approximately 2741 acres of hairy rattleweed habitat and directly destroyed individual plants. Hairy rattleweed populations are able to survive clear-cutting, but site preparation and replanting severely impact populations (U.S. Fish and Wildlife Service 1984, Humphrey 1987, Kral 1980). The effects of bedding, unnaturally high stocking densities of seedlings and fire exclusion in pine plantations are dramatically impacting this species (U.S. Fish and Wildlife Service 1984, Tassin and McGee 1999, Humphrey 1988, Leege and Squire 2006). High stocking densities are used to maximize the Net Present Value on industrial timber land. As a result, canopy closure is achieved and growing space is fully occupied, resulting in shading and elimination of the herbaceous ground cover, including hairy rattleweed. Following timber harvest, populations do not respond to the release from shading and competition with increased recruitment, as might be expected. The loss of ground cover contributes to a change in the fire community and reduces the opportunity for natural fires to play a role in the ecology to the site. In the past, wildfires and use of fire by man maintained habitat suitable for hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Suppression of fire has resulted in increased competition from shrubs, which is considered to be a major factor responsible for reduction in abundance of hairy rattleweed (U.S. Fish and Wildlife Service 1984). Fire is still used for forest management, but the frequency and time of year of burning may not be beneficial to hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987). The use of herbicides in powerlines and road rights-of-way could adversely affect populations of hairy rattleweed, although, the effects of herbicides are solely based on field observations. Two extant populations occur on 274 acres of hairy rattleweed habitat in areas where rural housing development has occurred. The houses and surrounding landscaping

directly destroy hairy rattleweed (USFWS, 2011).

**Stressor:** Drought (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is expected that severe drought could be a threat to small populations and would likely reduce recruitment into the population (USFWS, 2011).

***Recovery***

**Reclassification Criteria:**
Four self sustaining populations are secured (USFWS, 2011).

Recovery Priority Number: 5

**Delisting Criteria:**
1. There are at least eight self-sustaining populations secured and maintained within its historic or current range (eight would provide a reasonable degree of security against catastrophic loss and/or site alteration) (USFWS, 2011).

2. The number of individuals in the various populations has reached an optimum level or cover percentage and frequency occurrence, as established by management studies (USFWS, 2011).

3. Its biology is sufficiently understood to allow perpetuation of the species should circumstances require immediate or drastic alteration of populations and/or sites (USFWS, 2011).

4. Continuing protection and management after delisting are assured (U.S. Fish and Wildlife Service 1984) (USFWS, 2011).

**Recovery Actions:**
- Protect habitat and existing populations of the hairy rattleweed (USFWS, 1984).
- Monitor populations and their habitats (USFWS, 1984).
- Conduct searches for new stands of the hairy rattleweed (USFWS, 1984).
- Preserve existing germ plasm through cultivation and storage (USFWS, 1984).
- Conduct autoecological research (USFWS, 1984).
- Develop public awareness and support (USFWS, 1984).
- Investigate potential for longleaf pine planting on private land. Projects could be partially funded by the US Fish and Wildlife Service (USFWS, 2011).
- Secure funding for land acquisition to facilitate permanent protection for recovery of populations (USFWS, 2011).
- Implement conservation easements where possible (USFWS, 2011).
- Develop and distribute an information factsheet on hairy rattleweed (USFWS, 2011).
- Share with the local Natural Resource Conservation office information about the distribution and best management practices of hairy rattleweed (USFWS, 2011).

- Contact and cooperatively work with Okefenokee Electric Membership Cooperation/Georgia Department of Transportation regarding rights-of-way management (broadcast spraying along right-of-ways) (e.g., Georgia Power – mowing) (USFWS, 2011).
- Document change in industrial timber management over time and relate the change in management to the change in habitat (USFWS, 2011).
- Work with partners to help secure funding for protection and management efforts (USFWS, 2011).
- Reintroduce fire on select industrial timberland sites to study effects (USFWS, 2011).
- Create demonstration sites to establish effective hairy rattleweed habitat management (reflective of management guidelines that will be established and further researched) (USFWS, 2011).
- Investigate and provide incentives for hairy rattleweed management on private lands (e.g., appropriate mowing regimes or other management options) (USFWS, 2011).
- Prioritize tracts/sites for different purposes – acquisition/conservation, research plots, seedling recruitment, vulnerability to development, etc. (USFWS, 2011).
- Identify safeguarding sites (Sansavilla, others) for reintroduction efforts and potential expansion of the currently recognized distribution within historical area (USFWS, 2011).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS I. Conservation/Management Strategies 1. Secure funding for land acquisition to facilitate permanent protection for the recovery of hairy rattleweed populations. 2. Partner with Georgia Department of Transportation, Georgia Power, and the respective landowners to secure hairy rattleweed populations along rights-of way. 3. Work with timber companies on alternative management strategies that will promote hairy rattleweed populations, such as creating buffers along roadsides where populations occur. 4. Survey unknown populations. 5. Implement conservation easements on private land. 6. Work with public and private schools in Wayne and Brantley Counties to educate the youth about the endangerment of hairy rattleweed and to foster future recovery. 7. Reintroduce fire on select industrial timberland sites. 8. Create demonstration sites to establish effective hairy rattleweed habitat management (reflective of management guidelines that will be established and further researched). 9. Investigate and provide incentives for hairy rattleweed management on private lands (e.g., appropriate mowing regimes or other management options). 10. Collaborate with the Georgia Plant Conservation Alliance to propagate this species at botanical gardens or arboreta along the Coastal Plain of Georgia to help with future reintroduction efforts. II. Research Priorities 1. Re-survey long-term monitoring plots and GPS each site to document status across the range of hairy rattleweed. 2. Determine canopy cover relationships to vigor of plants and reproduction. 3. Characterize the vegetation and habitat requirements of hairy rattleweed. 4. Conduct additional inventory/surveys to more accurately predict the size of occupied polygons and the distribution of the species. 5. Characterize hydrology of hairy rattleweed sites. (USFWS, 2019)

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# SPECIES ACCOUNT: *Berberis nevinii* (Nevin's barberry)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An evergreen shrub, 1-4 m tall. Leaves have 3-5 leaflets with serrated, spine-tipped edges. Produces yellow flowers (March-April), followed by red or yellow-red berries (NatureServe, 2015).

**Taxonomy**

A member of the Berberidaceae (barberry family). Berberis nevinii is distinguished from other members of the genus by its nearly flat, narrow, serrate, pinnately veined leaflets, few flowered racemes, and reddish fruits (Munz 1974, p. 245; Niehaus 1977, p. 1; Williams 1993, pp. 362-363) (USFWS, 2009).

**Historical Range**

Its historical distribution likely consisted of fewer than 30 scattered occurrences in Los Angeles, San Bernardino, and Riverside Counties (Service 1998, p. 54958), and possibly San Diego County (Neihaus 1977, p. 1; Reiser 2001, p. 3; CNDDB 2008, Element Occurrence (EO) 45) (USFWS, 2009).

**Current Range**

Ranges from the foothills of the San Gabriel Mountains of Los Angeles County to near the foothills of the Peninsular Ranges of southwestern Riverside County, California (Fish and Wildlife Service 1998) (NatureServe, 2015).

**Critical Habitat Designated**

Yes; 2/13/2008.

**Legal Description**

On February 13, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Berberis nevinii (Nevin's barberry) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat units (CHU), in California (73 FR 8412-8440).

**Critical Habitat Designation**

The critical habitat designation for Berberis nevinii includes one CHU (six sub-units) in Rverside County, California. This species critical habitat encompasses approximately six acres (ac) (three hectares (ha)) (73 FR 8412-8440).

Unit 1: Agua Tibia/Vail Lake: Unit 1 comprises approximately 6 ac (3 ha) and is divided into two subunits: Big Oak Mountain Summit (1A) and Agua Tibia Mountain Foothills (1B). The lands in Unit 1 were occupied at the time of listing, contain the physical and biological features essential to the conservation of Berberis nevinii, and may be important for maintaining genetic diversity for the species as they include occurrences in ecologically unique areas. Subunit 1A: Big Oak Mountain Summit: Subunit 1A consists of approximately 5 ac (2 ha) of Federal land managed by the BLM on Big Oak Mountain to the north of Vail Lake in southern Riverside County. Two Berberis nevinii individuals of different sizes (ages) occur in this subunit on the summit of Big Oak Mountain at approximately 2,700 ft (823 m) elevation (i.e., the lower edge of the marine layer) (PCE 1 and 3). One individual is an old plant that is covered in lichens, and the other individual is considerably smaller and at some distance to the northeast of the older plant. This location is considered unusual (i.e., ecologically unique) for the species in that it is at higher elevation and on relatively flat clay lenses consisting of heavy adobe/gabbro type soils with high water-holding capacity, derived from Mesozoic basic intrusive rock (PCE 2) (Soza 2003, unpaginated). Soils in this area are classified primarily as Auld clay, 8 to 15 percent slopes, and Las Posas loam, 8 to 15 percent slopes, eroded (PCE 2) (Service GIS data 2006). This occurrence is located in an open grassland area with chaparral nearby. Associated plant species include Chenopodium californicum, Avena fatua, Harpagonella palmeri, Plantago erecta, Convolvulus simulans, Galium porrigens, and Delphinium sp. We are designating this subunit as critical habitat even though it is occupied by only two Berberis nevinii plants because it represents an ecologically unique site for the species and contains the physical and biological features essential to the conservation of B. nevinii. Additionally, this site contains naturally occurring B. nevinii of different sizes (ages). Because this occurrence is on an ecologically unique site, this subunit may be important in terms of preserving genetic diversity throughout the range of the species. Berberis nevinii occupied this subunit at the time of listing (63 FR 54956; October 13, 1998). Bureau of Land Management land on Big Oak Mountain consists of three small parcels totaling 888 ac (360 ha) surrounded by private land. The primary threats to Berberis nevinii habitat in this area are the indirect effects associated with urban and residential development on private lands adjacent to BLM lands, such as increased human recreation; incursion or spread of invasive, nonnative plants; and changes to the natural fire regime (i.e., increased ignitions and fire frequency, and shortened fire return intervals that can lead to type conversion of shrublands to annual grasslands). The BLM Resource Management Plan indicates that these parcels are closed to motorized vehicles and livestock grazing (BLM 1994, p. 28). However, special management considerations or protection for the physical and biological features may be needed to minimize disturbance to the vegetation and soils within this subunit; control invasive, nonnative plants; and maintain the natural hydrologic and fire regime of the area resulting from urban and residential development. Subunit 1B: Agua Tibia Mountain Foothills: Subunit 1B consists of approximately 1 ac (<1 ha) of federally-owned land managed by the USFS on the CNF near the Agua Tibia Wilderness Area in southern Riverside County, California. Five Berberis nevinii individuals are known from this area and are located at the edge of a stream channel (PCE 1) growing in association with coast live oak and riparian woodland species (PCE 3). Nearby chaparral includes such species as Quercus berberidifolia, Adenostoma fasciculatum, and Haplopappus squarrosus, and nearby desert species include Yucca schidigera (CNDDB 2007). These B. nevinii plants are growing under a canopy of Quercus agrifolia and Platanus racemosa with the following species: Heteromeles arbutifolia, Q. berberidifolia, Elymus condensatus, Mimulus aurantiacus, Lonicera subspicata, Pterostegia drymarioides, and Epilobium canum. Soils in this area are classified as rough broken land and Visalia gravelly sandy loam, with 5 to 9 percent slopes (PCE 2) (Service GIS data 2007). We are designating this subunit as critical habitat because it contains the physical and biological features essential to conservation of Berberis nevinii and it contains a relatively large natural occurrence of the species. Additionally, Service personnel visited this site in June 2006 while B. nevinii was in fruit and found that several of the fruits had three to four seeds, which may be significant for a species that appears to rarely set seed. Berberis nevinii occupied this subunit at the time of listing, as identified in the final listing rule (63 FR 54956, October 13, 1998). The Berberis nevinii occurrence on the CNF is not as well protected as the occurrence on the ANF (USFS 2005, p. 238).

The primary threats to B. nevinii habitat in this area are human recreation (off-highway vehicle use, shooting); wildland fire, including an increased risk of fire ignition due to the proximity of State Highway 79 (USFS 2005, pp. 232, 237); fuels and fire management activities (USFS 2005, p. 237); and invasive, nonnative plants, including potential short-term adverse effects associated with control efforts (USFS 2005, p. 234). This occurrence on the CNF burned in 1996 and vigorously resprouted following the fire (USFS 2005, p. 237). According to the USFS, this location has shown signs of disturbance from road activities, with unauthorized use of off-highway vehicles occurring close to, but not within, the area occupied by the species (USFS 2005, p. 235). Nonetheless, the magnitude of impacts associated with roads and recreational activity in this area appears to be low (USFS 2005, p. 238). Also, the USFS does not anticipate substantial camping and hiking-related impacts to B. nevinii habitat, and intends to avoid or mitigate these impacts through implementation of Forest Plan standards (USFS 2005, p. 234). The February 6, 2007, proposed rule (72 FR 5552) identified the proximity of Highway 79 as a potential threat to the Berberis nevinii occurrence and habitat on the CNF, in part due to proposed highway widening and realignment activities (72 FR 5565). However, we no longer anticipate that these activities will affect Subunit 1B as there currently are no plans for widening or realigning Highway 79 in the section of roadway closest to this subunit. The revised subunit is now more than 525 ft (160 m) south of the highway. As discussed in the Special Management Considerations or Protection section above, the presence of invasive, nonnative plants may impact the B. nevinii occurrence and habitat at this site. However, the CNF anticipates an eradication effort of the nonnative Arundo donax and other invasive grasses (USFS 2005) present in this subunit, which should minimize the impacts of this threat to the species and its habitat. One of the greatest threats to occupied habitat on the CNF and the physical and biological features contained therein is from wildland fire and the management of fire and fuels (i.e., fire suppression and prevention activities). This subunit is within the Wildland-Urban Interface (WUI) Defense Zone (USFS 2005, p. 237; Service 2005, p. 127). Some plants or habitat within the WUI Defense Zone could be removed or degraded under the Revised Land and Resource Management Plan due to fuel removal for fire protection or overly frequent fuel treatments (Service 2005, p. 127). Special management considerations or protection of the physical and biological features may be required to minimize disturbance to the vegetation and soils within this subunit; control invasive, nonnative plants; and maintain the natural fire regime of the area.   Subunit 1C: South Flank Big Oak Mountain:  We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.   Subunit 1D: North of Vail Lake:  We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.   Subunit 1E: South of Vail Lake/ Peninsula:  We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.   Subunit 1F: Temecula Creek East:  We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Berberis nevinii critical habitat consists of three components (73 FR 8412-8440):

(i) Low-gradient (i.e., nearly flat) canyon floors, washes and adjacent terraces, and mountain ridge/summits, or eroded, generally northeast to northwest-facing mountain slopes and banks of dry washes typically of less than 70 percent slope that provide space for plant establishment and growth;

(ii) Well-drained alluvial soils primarily of non-marine sedimentary origin, such as Temecula or sandy arkose soils; soils of the CajalcoTemescal-Las Posas soil association formed on gabbro (igneous) or latite (volcanic) bedrock; metasedimentary substrates associated with springs or seeps; and heavy adobe/gabbro-type soils derived from metavolcanic geology (Mesozoic basic intrusive rock) that provide the appropriate nutrients and space for growth and reproduction; and

(iii) Scrub (chaparral, coastal sage, alluvial, riparian) and woodland (oak, riparian) vegetation communities between 900 and 3,000 feet (275 and 915 meters) in elevation that provide the appropriate cover for growth and reproduction.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas within the geographical area occupied by the species at the time of listing contain the physical or biological features essential to the conservation of the species, and whether these features may require special management considerations or protection. As stated in the final listing rule (63 FR 54956, October 13, 1998), threats to the species and its physical and biological features include urban development, off-road vehicle use, human recreation (e.g., horseback riding), highway projects, fire management strategies (suppression measures, brush clearing) that alter natural fire processes to which native plant communities are adapted, and the introduction of invasive, nonnative plants that may compete with Berberis nevinii or contribute to combustible fuel loads (63 FR 54961). These threats can directly or indirectly result in the loss, modification, degradation, or fragmentation of B. nevinii habitat, thereby eliminating or reducing potential habitat for seed production and germination, seedling establishment, plant growth and maturation, and population growth. Individually or combined, these threats may require special management considerations or protection of the physical and biological features as addressed here and in more detail within the individual critical habitat unit descriptions that follow. Urbanization, flood control measures, road widening, and habitat degradation from extensive recreational use have contributed to the loss of Berberis nevinii habitat and have apparently resulted in the extirpation of several occurrences, particularly in the San Fernando Valley of Los Angeles County (63 FR 54961). Urban development is currently the primary threat to B. nevinii habitat and occurrences in the vicinity of Vail Lake and Oak Mountain in Riverside County. Urbanization may destroy, degrade, fragment, or otherwise alter the topography, soil, and vegetation community structure in ways that make areas less suitable for B. nevinii. Land grading for residential development and road projects may affect the topography of the site (PCE 1); alter soil composition and structure (PCE 2); change vegetation community composition and structure through clearing or thinning of vegetation and the introduction of nonnative plants (PCE 3); increase erosion potential (PCE 1 and 2); and change hydrological (drainage and water infiltration) patterns, thereby decreasing the quality and extent of available habitat for B. nevinii. Additionally, urban development within or near B. nevinii habitat may increase the frequency of fire on the landscape due to increased combustible fuel loads that may result from the incursion and spread of annual nonnative grasses and an increased potential for fire ignition. In the February 6, 2007, proposed rule (72 FR 5552), we focused primarily on potential indirect impacts of urbanization on Berberis nevinii habitat and occurrences in the vicinity of Vail Lake and Oak Mountain (72 FR 5565– 5567). Urban development is not expected to directly impact the known occurrences of B. nevinii on Federal land in the Vail Lake and Oak Mountain area, although indirect impacts associated with increased urbanization may occur. On the other hand, B. nevinii habitat on private land in this area may be subject to some degree of residential development, as described below in the critical habitat subunit descriptions (see the Critical Habitat Designation section of this final rule). However, these private lands are located within the Criteria Area of the Western Riverside County MSHCP and are targeted, in whole or in part, for acquisition and inclusion in the MSHCP Conservation Area as Additional Reserve Lands. Specifically, the conservation objectives of the MSHCP include conservation and management of at least 8,000 ac (3,238 ha) of suitable habitat, including all known locations of B. nevinii in the Vail Lake area (see the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a detailed discussion of the MSHCP). Recreational activities may also impact the physical and biological features essential to the conservation of the species by destroying, degrading, fragmenting, or otherwise altering the topography, soil, and vegetation community in ways that make areas less suitable for Berberis nevinii. For example, off-highway vehicle use, hiking, camping, horseback riding, and recreational facility development in or near B. nevinii occurrences could alter or destroy surface and subsurface structure through trampling and clearing or thinning of vegetation (PCE 3), the introduction of nonnative plants (PCE 3), soil disturbance or compaction (PCE 2), and increased erosion and changes to hydrological (drainage and water infiltration) patterns that may in turn affect the topography, soil, and vegetation of the site (PCE 1, 2, and 3). Activities associated with fire management, such as fuel treatments, prescribed burns, and wildfire suppression, may also impact the physical and biological features essential to the conservation of the species. The creation of fuel breaks, brush clearing or thinning, and the use of heavy equipment and off-road vehicles for fire management could physically remove or disturb soils and alter soil composition (PCE 2), remove or destroy vegetation (PCE 3), increase erosion, and alter the topography (PCE 1) and hydrologic patterns in or near Berberis nevinii occurrences. Fire management activities could facilitate the incursion or spread of invasive, nonnative plants by potentially dispersing seeds and creating (disturbance) conditions that increase the competitive edge of nonnative species over native species, thereby altering the composition of the vegetation community (PCE 3). As pointed out in the proposed critical habitat rule (72 FR 5552), vegetation community composition and structure could be altered by fire management activities such as prescribed fires that are too frequent or that occur at times of the year atypical of the natural fire regime, or by fire suppression that allows overgrowth of high canopy cover, limiting or eliminating plant species that require full or partial sun from the plant community (72 FR 5563). Berberis nevinii's life history characteristics indicate that it likely recruits into chaparral during fire-free periods and may require long intervals between fires for recruitment and population increases; thus, overly frequent fire is a substantial and immediate threat to this species (White 2007, p. 1). While highway projects were identified in the final listing rule (63 FR 54956, October 13, 1998) and proposed critical habitat rule (72 FR 5552; February 6, 2007) as a threat to Berberis nevinii, we do not anticipate that this activity will affect designated critical habitat in the foreseeable future. Specifically, the proposed critical habitat rule identified the proximity of Highway 79 as a potential threat to the B. nevinii occurrence and habitat on the CNF (Subunit 1B) in part due to proposed highway widening and realignment activities (72 FR 5565). However, we no longer anticipate that these activities will affect Subunit 1B because: (1) There are currently no plans to widen the portion of State Route 79 closest to Subunit 1B, and (2) the revised subunit is now more than 525 ft (160 m) south of the highway, which is far enough away that impacts to the subunit from construction or widening activities are unlikely. Based on information provided for the economic analysis, nonnative Arundo donax (Arundo) and other invasive grasses are present in Subunit 1B, and the CNF anticipates an eradication effort based on the weed management strategy in the USFS' Revised Land Management Plan for the Four Southern California National Forests (USFS 2005). Additional information obtained on water storage at Vail Lake indicates that lake level fluctuations could affect proposed subunits bordering Vail Lake (specifically, proposed subunits 1D and 1E). While we revised proposed critical habitat boundaries for these subunits based on the currently permitted storage capacity of Vail Lake (see the Criteria Used to Identify Critical Habitat section in this final rule), fluctuating water levels that surpass permitted storage levels and lake storage capacity could still affect Berberis nevinii in subunits that border Vail Lake. However, the occurrences that are located closest to Vail Lake have not been inundated or affected by rising water levels and fluctuations in the recent past (Boyd 2007, p. 1), and we do not anticipate that any B. nevinii individuals in this area will be affected.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2009)

**Lifespan**

Adult: > 50 years (USFWS, 2009)

**Breeding Season**

Adult: March - April (USFWS, 2009)

**Reproduction Narrative**

Adult: This species flowers from March through April. Berberis nevinii shrubs are long-lived (more than 50 years) (Mistretta and Brown 1989, p. 5) with low reproductive rates likely due to sporadic production of fertile seed (Mistretta and Brown 1989, p. 5). Several occurrences of B. nevinii consist of only single plants that have existed for years or decades without reproducing sexually (Mistretta and Brown 1989, p. 5), suggesting a self-incompatible breeding system (White 2001, p. 36). Berberis nevinii likely does not reproduce by vegetative means (Mistretta and Brown 1989, p. 5; S. Boyd, Rancho Santa Ana Botanic Garden, in litt. 2006, p. 1) (USFWS, 2009).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Alluvial shrub communities, chaparral (NatureServe, 2015); oak woodland, riparian scrub, riparian woodland (USFWS, 2009)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (USFWS, 2009)

**Geographic or Habitat Restraints or Barriers**

Adult: 1,400 - 2,700 ft. elevation (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2009)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 2009)

**Habitat Narrative**

Adult: This species is found in 2 habitat types: the margins of dry washes with sandy and gravelly substrates and alluvial shrub communities; and steep slopes with coarse soils and chaparral communities. The presence of groundwater flow may be a habitat requirement (NatureServe, 2015). This species generally grows on sandy soils in low-gradient washes, alluvial terraces, and canyon bottoms, along gravelly wash margins, or on coarse soils on steep, generally north-facing slopes in association with the following plant communities: alluvial scrub, cismontane (e.g., chamise) chaparral, coastal sage scrub, oak woodland, and/or riparian scrub or woodland. Berberis nevinii is a fire-adapted species, where mature individuals may survive and re-sprout following fire (Mistretta and Brown 1989, p. 5; White and Leatherman 2001, p. 36). Most native occurrences of B. nevinii are between 1,400 and 1,700 feet (427 to 518 meters) in elevation (Boyd 1987, p. 2; CNDDB 2008, pp. 1–34), although one native occurrence on the Oak Mountain summit north of Vail Lake is at approximately 2,700 feet (823 meters). Native occurrences are strongly associated with alluvial soils or soils derived from nonmarine sedimentary based substrates, especially sandy arkose (sandstone derived from granitic material) (Boyd 1987, p. 7; Boyd and Banks 1995, p. 24; Soza and Boyd 2000, p. 25). Berberis nevinii is considered a drought-tolerant species, but it will also tolerate large amounts of water in cultivation without apparent damage (Wolf 1940, p. 2; Lenz and Dourley 1981, p. 130; A. Sanders, University of California Riverside, in litt. 1997, p. 2) (USFWS, 2009).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Fruits are adapted for animal dispersal (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Declining (inferred from NatureServe, 2015)

**Number of Populations:**

14 native (USFWS, 2009)

**Population Size:**

< 370 (USFWS, 2009)

**Population Narrative:**

Historically, the range of this species probably consisted of fewer than thirty scattered occurrences. At least seven populations of the thirtyish known occurrences have been extirpated (Fish and Wildlife Service 1998) (NatureServe, 2015). Currently, there are 14 extant, native occurrences of Berberis nevinii. The total number of native B. nevinii individuals across its range may be less than 370 (USFWS, 2009).

***Threats and Stressors***

**Stressor:** Urbanization (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A majority of the occurrences and individuals of B. nevinii are on private lands subject to urbanization. Urban development is the primary threat to Berberis nevinii and its habitat in the vicinity of Vail Lake (USFWS 2008a, p. 8423). Land grading for residential development and associated roads may affect the topography of the site; alter soil composition and structure; change vegetation community composition and structure through clearing or thinning of vegetation and the introduction of nonnative plants; increase erosion potential; and change hydrological (drainage and water infiltration) patterns, thereby decreasing the quality and extent of available habitat for B. nevinii. In addition, urban development may increase the frequency of fire on the landscape due to increased combustible fuel loads and potential for fire ignition resulting from the incursion and spread of annual nonnative grasses (USFWS, 2009).

**Stressor:** Recreation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, hiking, camping, and recreational facility development have been included with off-road vehicles and horseback riding as recreational activities that threaten Berberis nevinii (USFWS 2008a, p. 8423). These activities may alter or destroy surface and subsurface structure through trampling and clearing or thinning of vegetation, the introduction of nonnative plants, soil disturbance or compaction, and increased erosion and changes to hydrological (drainage and water infiltration) patterns (USFWS 2008a, p. 8423). Although not discussed in the listing rule, recreational uses associated with the Vail Lake Village Resort and Campground (private) and the Dripping Springs Campground (Cleveland National Forest) were identified as a threat to three Berberis nevinii occurrences (CNDDB 2008, EOs 2, 20, 24). Since listing, hiking and biking along an adjacent fire road was noted as threat to the Cobal Canyon occurrence consisting of a single individual (CNDDB 2008, EO 46). At least 36 percent (5 of 14) of Berberis nevinii occurrences are currently known to be threatened by recreational activities. Seven additional occurrences near urban areas are likely threatened by these activities due to lack of protection from off-road vehicle access and close proximity to roads (USFWS, 2009).

**Stressor:** Proposed road widening (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** A proposal to widen State Route 79 (SR-79) south of Vail Lake was noted as a potential threat as it may directly impact B. nevinii occurrences and promote development in the area (USFWS 1998, p. 54961). An occurrence consisting of two plants in Arroyo Seco Creek (Table 1) is in close proximity to SR-79. According to geographic information system (GIS) data provided by the County of Riverside, planned widening of SR-79 in that area partially overlaps one of the B. nevinii individuals mapped in CNDDB (Dudek 2003a, pp.7-25, 7-26, 7-31; USFWS GIS data 2008) (USFWS, 2009).

**Stressor:** Altered fire regimes (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Activities associated with fire management, such as fuel treatments, prescribed burns, and wildfire suppression, may impact the physical and biological features essential to the conservation of Berberis nevinii. The creation of fuel breaks, brush clearing or thinning, and the use of heavy equipment and off-road vehicles for fire management could physically remove or disturb soils and alter soil composition, remove or destroy vegetation, increase erosion, and alter the topography and hydrologic patterns in or near B. nevinii occurrences. Fire management activities could facilitate the incursion or spread of invasive, nonnative plants by potentially dispersing seeds and creating (disturbance) conditions that increase the competitive edge of nonnative species over native species, thereby altering the composition of the vegetation community (USFWS 2008a, p. 8423). increases in urbanization and human activity in or near B. nevinii habitat are generally accompanied by an increased incidence of accidental fires (USFWS 1998, p. 54964). Overly frequent fire on the landscape could potentially kill young B. nevinii before they reach their reproductive potential and may adversely affect mature B. nevinii by causing repeated resprouting that depletes stored resources faster than they can accumulate during fire-free periods (White 2007, in litt., p. 1). In addition, repeated burnings over short intervals could eventually lead to type conversion (wholesale replacement) of chaparral/shrublands with nonnative annual grassland (Keeley et al. 1999, p. 1831) (USFWS, 2009).

**Stressor:** Small population size and low reproductive output (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, the total number of native Berberis nevinii individuals across its range was reduced from 500 to fewer than 370 because of the reclassification of the San Francisquito Canyon occurrences from native to nonnative. In addition, 57 percent (8 of 14) of B. nevinii occurrences consist of three or fewer individuals, and 29 percent (4 of 14) of occurrences consist of only one individual. Low reproductive output of Berberis nevinii may be evidence of the potential impact of small population size on fitness described above. There appears to be little to no regeneration by seed occurring at most B. nevinii sites (Mistretta 1994, p. 186). Low seed set (including plants bearing fruits that lack seed) and lack of viable seed has been noted by both botanists and horticulturalists trying to obtain seed for propagation, even from within larger occurrences (Wolf 1940, p. 2; Boyd 1987, pp. 3, 44, 56; Mistretta and Brown 1989, pp. 4–5; Mistretta 1994, p. 186; Wall 2009, in litt., p. 5). In addition, several occurrences of B. nevinii consist of only a single plant that has existed for years or decades without reproducing (Mistretta and Brown 1989, p. 5; CNDDB 2008, EO 5). (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** One study predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Whether or not this would include Berberis nevinii is unknown. While the Service recognizes that climate change is an important issue with potential effects to listed species and their habitats, it lacks adequate information to make accurate predictions regarding its effects to B. nevinii at this time. Any changes in fire frequency resulting from climate change could directly threaten the persistence of the fire-prone occurrences of B. nevinii near Vail Lake in Riverside County (USFWS, 2009).

**Stressor:** Recreational activities (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the 2009 5-year review, we discussed recreational threats to Berberis nevinii at four locations (San Timoteo Canyon, Dripping Springs Campground, Vail Lake, and Cobal Canyon). Off-road vehicles, horseback riding, hiking, camping, and recreational facility development were all listed as threats to B. nevinii (USFWS 2009, p. 14). (USFWS, 2021)

**Stressor:** Urbanization (Residential development) (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the 2009 5-year review for Berberis nevinii, development was considered an immediate threat to the species, due to a proposal to develop the Vail Lake area (USFWS 2009, p. 13). In 2014, the Rancho California Water District (RCWD) acquired the lands encompassing the Vail Lake occurrences of Berberis nevinii, eliminating the immediate threat of residential development. The area is not under permanent conservation (for example, through conservation easement). However, RCWD management objectives for the area include habitat conservation and restoration (RCWD 2016, p. 6). We do not have information about other ownership or conservation status changes at other Berberis nevinii occurrences since 2009. (USFWS, 2021)

***Recovery***

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

Recovery Priority Number: 8

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

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

- Cooperate with the Western Riverside Regional Conservation Authority to acquire occupied Berberis nevinii habitat around Vail Lake, and to establish land management practices on these lands that will benefit the species (USFWS, 2009).
- Determine causes and remedies of low reproductive output in Berberis nevinii. Investigate its breeding system; pollinators; seed dispersal mechanisms; and seedling requirements and establishment (USFWS, 2009).
- Work with partners to help conserve Berberis nevinii. Identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities (USFWS, 2009).
- Identify partners to help support efforts to survey Berberis nevinii occurrences around Vail Lake, including occurrences within or partially within the perimeter of the 2004 Eagle fire (USFWS, 2009).
- Verify presence of the occurrence near the mouth of Scott Canyon in San Bernardino County (USFWS, 2009).
- Determine the genetic origins of cultivated specimens that are successfully reproducing, in particular, the Berberis nevinii in San Francisquito Canyon (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Monitor known occurrences of Berberis nevinii, with a focus on occurrences not monitored by the California Botanic Garden or the Western Riverside County Multiple Species Habitat Conservation Plan. Survey surrounding areas of suitable habitat for additional plants. 2. Collect additional B. nevinii seeds for ex situ storage at a certified Center for Plant Conservation facility. Focus collection efforts on occurrences that are not yet represented in conservation seed collections. 3. Work with the Rancho California Water District to conserve and enhance the Vail Lake occurrences of B. nevinii. For example, census the Vail Lake population, collect seed, and assess threats associated with recreational use. 4. Model B. nevinii habitat under a range of future climate scenarios and evaluate current and future areas of suitable habitat to identify opportunities for assisted migration. 5. Reintroduce B. nevinii to areas of suitable habitat within the species' range. 6. Augment B. nevinii occurrences where occurrence size is small. Increase occurrence size by planting additional B. nevinii. Work with conservation botanists to determine genetic management strategies for small occurrences. 7. Restore and enhance B. nevinii habitat where needed (for example, by controlling nonnative plants). (USFWS, 2021)
- Conservation Efforts As part of the genetics and breeding system study, California Botanic Garden botanists developed a propagation protocol for Berberis nevinii and obtained two conservation collections of B. nevinii seed from SFC (Washburn and Fraga 2017, p. 16). In addition to the two new seed collections from SFC, there are four other conservation collections of Berberis nevinii seed at California Botanic Garden (CBG 2020, unpaginated): 1. In 1990, B. nevinii was collected from SFC (accession number 16285). 2. In 2003, B. nevinii was collected from multiple plants within California Botanic Garden (accession number 21182). 3. In 1989 and 1990, B. nevinii was collected from CNDDB EO 16 (Vail Lake) (accession numbers 16073 and 16284, respectively). California Botanic Garden is working on a project to complete additional conservation activities for Berberis nevinii on the Angeles National Forest. The study includes 1) continued monitoring of B. nevinii at SFC, 2) a habitat suitability model to identify potential outplanting locations within the Copper Fire burn area, 3) a restoration out-planting, which will be documented over 5 years, and 4) additional ex situ seed conservation (Fraga 2019, unpaginated; Fraga 2020, pers. comm.). (USFWS, 2021)

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# SPECIES ACCOUNT: *Betula uber* (Virginia round-leaf birch)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 5/27/1978; Northeast Region (R5) (USFWS, 2016)

**Physical Description**

A deciduous, moderate-sized tree, up to 15 m tall, with smooth dark-brown to black, aromatic bark and a compact crown. The alternately arranged, simple leaves are round to slightly oblong in outline, 3.3-5.3 cm long, hearth shaped at the base, rounded to obtuse at the tip, with 4-5 pairs of lateral veins and 21-33 coarse teeth along each margin. The fruiting structures (catkins) are 1.7 - 2.8 cm long and possess nearly smooth, 4.8-6.0 mm long scales with three broadly divergent lobes. At the base of each scale are three winged nutlets (samaras), ranging in length from 1.7-2.0 mm (USFWS, 1990).

**Taxonomy**

Originally described as a variety of the common sweet birch or black birch (Betula lenta L.) by W.W. Ashe (1918). The taxon was subsequently elevated to the species level by M.L. Fernald (1945) and transferred from series Costatae (dark—barked tree birches) to series Humiles because of presumed affinities to the shrub birches (USFWS, 1990).

**Historical Range**

See current range/distribution.

**Current Range**

Known from a 700-m stretch of highly disturbed, second-growth forest less than 100 m wide along the banks of Cressy Creek, near the town of Sugar Grove, in Smyth County, Virginia (USFWS, 1990).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Abiotic (EPA, 2016)

**Breeding Season**

Adult: Flowers in late April to early May with fruiting in September (USFWS, 2016)

**Reproduction Narrative**

Adult: Reproduction is abiotic, with pollination by wind (EPA, 2016). The tree flowers in late April to early May with fruiting in September (USFWS, 2016).

**Habitat Type**

Adult: Terrestrial, Wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forested riparian (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (USFWS, 2016)

**Habitat Narrative**

Adult: This birch is a subcanopy tree growing in rocky debris that is strongly acidic and very permeable. The natural population is within a narrow strip of second-growth forest that includes many sweet and yellow birches. The band of forest is nearly surrounded by agricultural land (USFWS, 2016).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

**Dispersal/Migration Narrative**

Adult: Seed dispersal is by wind (EPA, 2016).

***Population Information and Trends***

**Population Trends:**

Stable (USFWS, 2006)

**Species Trends:**

Stable (inferred from USFWS, 2006)

**Number of Populations:**

1 (USFWS, 2020)

**Population Size:**

1 wild; 926 in progeny plots in 2008 (USFWS, 2020)

**Population Narrative:**

The Virginia round-leaf birch is known from a single natural population, which contains individuals that were originally rediscovered in the wild in 1975 (Service 1990). This population, contained within a fenced plot on USFS land for its protection, has dwindled in the last 15 years, from 8 extant individuals reported in 2006 (Service 2006) to 1 individual in 2017 (Bresowar 2020). Additional individuals of B. uber occur at this location, but are not considered to be natural since they were planted as part of recovery efforts. In addition to the natural population, 20 progeny plots containing planted greenhouse-grown individuals were established on USFS land in the 1980s, to help recover the species. Progeny plots have been periodically monitored by USFS staff, to ensure that they are not damaged by active timber sales occurring in adjacent lands (T. Blevins, USFS, email to A. Irizarry, Service, February 3, 2020). A full inventory of the species has not been conducted since 2008, when a total of 926 individuals of round-leaf birch were reported for all 20 progeny plots (USFS 2008). While the number of extant individuals has not been systematically assessed since 2008, populations informally visited by USFS appear to be stable (T. Blevins, USFS, email to A. Irizarry, Service, February 3, 2020). In addition to the natural population and progeny plots, there is 1 individual located at the Mount Rogers National Recreation Area office yard. Other natural trees are likely to occur on private land, however, the status of those individuals remains unknown (T. Blevins, USFS, email to A. Irizarry, Service, February 19, 2020). The 5-year review from 2012 (Service 2012) indicated the single natural population had been declining due to presumed natural mortality and lack of reproduction. Since then, no seedlings or evidence of reproduction have been observed either at the natural population site or any of the progeny plots. To restore favorable conditions for natural reproduction, all progeny plots require vegetative management. B. uber produces abundant seeds every 3-4 years (known as a mast year) and requires exposed mineral soil and forest openings to establish itself. Natural reproduction is expected to occur when one of these mast years coincide with suitable habitat availability, an event that seems to be rare. (USFWS, 2020) A full inventory of the species has not been conducted since 2008, when a total of 926 individuals of round-leaf birch were reported for all 20 progeny plots (USFS 2008). (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat destruction, modification, or curtailment or its habitat or range (USFWS, 2006)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species needs small forest openings, especially during years that it produces abundant seed. Rarely do these two factors coincide. Thus, natural reproduction is rare; it has only been documented once - in 1981-1982. The natural population is surrounded by agricultural land. Because the species relies on wind for pollination and seed dispersal, opportunities for range expansion are limited (USFWS, 2006).

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2006).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Overcollection for cultivation and research was a problem until the 1990s, when seeds that were germinated in captivity provided ample seedlings. In addition, providing propagated plants to the nursery trade created a supply of commercially available round-leaf birches that has virtually eliminated the demand for the wild plants (USFWS, 2006).

**Stressor:** Disease or predation (USFWS, 2006).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Disease is not a threat, but herbivory by deer, rabbits, mice, and domestic livestock has been a problem. Cages placed around seedlings have proven effective in reducing herbivory (USFWS, 2006).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2006).

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Plants on U.S. Forest Service property are protected by the ESA, but the plants on private prope1iy are not protected unless an action has Federal involvement (USFWS, 2006).

***Recovery***

**Reclassification Criteria:**
Not available.

Recovery Priority Number: 8

**Delisting Criteria:**
Establishment of 10 self-sustaining populations, defined of the basis of having each produced through natural regeneration 500-1000 individuals > 2 m tall (USFWS, 1990). The recovery objective for B. uber is to delist the species by increasing the number of individuals in the wild and meeting the following condition: “establishment of 10 self-sustaining populations, defined on the basis of having each produced through natural regeneration 500-1,000 individuals > 2 meters tall. The populations may include individuals of sweet birch (Betula lenta) which carry the round-leaf trait in a cryptic (heterozygous) state.” (USFWS, 2020)

**Recovery Actions:**
- Manage existing individuals and habitat for maintenance and expansion of the single wild population. Provide immediate protection for existing habitat. Monitor individuals for general condition and incidence of disease and insect infestations. Expand zone of management adjacent to existing population. Consider purchase of private property should it become available. Determine essential habitat. Encourage natural regeneration (USFWS, 1990).
- Retain existing germplasm through cultivation. Distribute propagated materials to public and private sectors. Establish pollen and seed banks (USFWS, 1990).
- Determine the systematic relationships of round-leaf birch. Conduct morphological. anatomical, and chemical studies on existing individuals of round-leaf birch and closely related taxa. Conduct studies of the reproductive and genetic systems of round-leaf birch and closely related taxa (USFWS, 1990).
- Establish and maintain additional natural populations. Establish several sites containing numerous genotypes. Maintain sites to reduce competition and retain vigor (USFWS, 1990).
- Implement educational programs to facilitate management of round-leaf birch (USFWS, 1990).
- Continue search for additional natural populations (USFWS, 1990).
- The recovery plan should be revised to include required threats-reduction criteria and to focus on actions conducive to achieving in situ reproduction (USFWS, 2006).
- The taxonomy of the birch is not universally agreed upon. Scientific evidence to date has been inconclusive, as some evidence points to the species level and some points to the variety level. If the plant is determined to be a variety, the variety should remain listed under the ESA until revised recovery criteria are met (USFWS, 2006).

- Natural reproduction is the most essential recovery criterion not yet met. The U.S. Forest Service should conduct management activities to expose mineral soil and remove other nearby birch species as they did in 1981. The management actions need to occur until a year when the Virginia round-leaf birch produces abundant seeds. Once ten populations reproduce naturally (in situ), delisting may be warranted (USFWS, 2006).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1) Develop and implement short-term management activities that improve the potential for natural reproduction in the progeny plots and natural population plot. Specifically, competing vegetation should be cleared from all plots in which the species occurs. 2) The Service should continue to work with USFS to identify further management actions that expose mineral soil to create appropriate conditions for seed set. 3) Conduct additional studies to improve understanding of the species' current reproduction conditions and reasons for apparent low-reproductive rates. 4) Perform an inventory of the species within the natural population plot and the 20 progeny plots. Surveys are needed to update current population size and to monitor population trends over time, seed production, and evidence of reproduction within the plots. 5) Conduct additional genetic analyses to clarify whether the birch is a species or a variety. 6) Develop and implement a plan to assess the status of the species on private lands. (USFWS, 2020)

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# SPECIES ACCOUNT: *Blennosperma bakeri* (Sonoma sunshine)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 1/2/1992; Pacific Southwest (R8)

**Physical Description**

Blennosperma bakeri plants are less than 30 centimeters (cm) (11.8 inches (in)) tall with alternate, linear leaves (Ornduff 1977a, Baldwin 2012). The leaves have smooth margins and are 5.1 to 15.2 cm (2.0 to 6.0 in) long with zero to five lobes (Baldwin 2012). From March to May, the plants have a butter-yellow, daisy-like flower head at the tip of each branch. Each flower head is less than 1.5 cm (0.6 in) across. The 6 to 15 outer petals are 5 to 7 millimeters (mm) (0.20 to 0.28 in) long. Occasionally the flowers may be white instead of yellow. The pollen is white. The flowers produce tapered achenes (dry, one-seeded fruits) that are 3 to 4 mm (0.12 to 0.16 in) long and have 4 to 6 sharp angles along the sides. The achenes are covered with tiny bumps and become slimy when wet giving the species one of its common names, “Baker’s sticky seed” (Ornduff 1963, Munz and Keck 1968, Ornduff 1977a, Baldwin 2012). (USFWS, 2016)

**Taxonomy**

Blennosperma bakeri is an annual plant in the aster family. It has been known by the scientific name Blennosperma bakeri (Heiser) since it was first described by Heiser (1947). Two other species are recognized in this genus; B. nanum (dwarf blennosperma) grows in California and B. chilense (Chilean blennosperma) occurs in Chile (Baldwin 2012). (USFWS, 2016)

**Historical Range**

Sonoma County, California. (USFWS, 2016)

**Current Range**

Sonoma County, California. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2016)

**Lifespan**

Adult: ~ 1 year (USFWS, 2016)

**Dependency on Other Individuals or Species**

Adult: Pollinators, such as Andrena blennospermatis (USFWS, 2016)

**Breeding Season**

Adult: March - April (USFWS, 2016)

**Key Resources Needed for Breeding**

Adult: Heavy fall rains, insect pollinators (USFWS, 2016)

**Reproduction Narrative**

Adult: Flower from March through April. The flowers of B. bakeri are self-incompatible, meaning that they can set seed only when fertilized by pollen from a different plant (USFWS, 2016). Blennosperma bakeri is an annual; its entire life cycle from seed germination to seed set is completed in a single growing season. In nature, B. bakeri seeds germinate in the fall following heavy rains, and the plants can grow even when submerged (Patterson et al. 1994). The most abundant native pollinator of B. bakeri was the solitary bee, Andrena blennospermatis. Other pollinators that visited B. bakeri included Apis mellifera (European honeybee), four species of generalist native bees, and syrphid flies. Under dry conditions, or in dense populations, B. bakeri may bear only a single flower head per plant (Patterson et al. 1994), thus producing a maximum of 15 achenes. However, when pools dry and fill repeatedly in a single growing season, each plant may produce as many as 20 flower heads (Patterson et al. 1994), with potential for 300 achenes per plant (USFWS, 2016).

**Habitat Type**

Adult: Wetland, aquatic (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Vernal pool, wet grassland (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs < 330 ft. elevation (USFWS, 2016)

**Environmental Specificity**

Adult: Very Narrow (Inferred from USFWS, 2016)

**Habitat Narrative**

Adult: Occurs predominantly on the Santa Rosa Plain, which is located in central Sonoma County, California, and is characterized by seasonal wetlands, predominately in the form vernal pools, and associated upland grassland habitat. Vernal pools form in depressions having a shallow, impermeable soil layer that restricts the downward movement of water. The pools have an outlet barrier that further causes ponding (CH2M Hill 1995) and may be connected and fed by shallow drainage pathways called “swales.” Vernal pools generally fill during winter rains and dry in late spring or summer. “Natural” vernal pools are those that are found occurring naturally in the landscape. “Created” vernal pools are those that have been constructed in an area that was not a vernal pool in the recent past (within the last 100 to 200 years) and that is isolated from existing vernal pools (Gwin et al. 1999 and Lewis 1989). This species grows only in seasonal wetlands. (USFWS, 2016)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal mechanisms for the achenes have not been studied. However, seed dispersal of B. nanum var. nanum, a species that occupies similar habitat to B. bakeri, was found by Ornduff

(1964) to be within a small radius of the parent plants based on the area occupied by flower-color variants. (USFWS, 2016)

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2016)

**Species Trends:**

Decreasing (USFWS, 2016)

**Number of Populations:**

19 presumed extant occurrences (USFWS, 2024)

**Population Size:**

Variable among years; < 100 to > 1.5 million (USFWS, 2016)

**Additional Population-level Information:**

Historically, Sonoma sunshine was only known to occur in Sonoma County. At the time of listing, the species was known from 35 sites in the Santa Rosa Plain and seven sites from the Sonoma Valley (Service 1991, p. 61173). The current known distribution of Sonoma sunshine is similar to as described in the previous status review (Diversity Database 2024, entire). The Diversity Database currently reports 24 occurrences (Appendix, Table A; Diversity Database 2024, entire). All of these occurrences, aside from the single occurrence in Mendocino County, are in Sonoma County. Since listing, Sonoma sunshine has been introduced to at least 12 new sites during mitigation activities or to establish conservation banks (Service 2016, p. 5). Populations of Sonoma sunshine exhibit extreme fluctuations in size among years, often varying by one or two orders of magnitude (Diversity Database 2013, as cited in Service 2016, p. 8). Individual occurrence sizes ranged over time from fewer than 100 plants to more than 1.5 million plants (Diversity Database 2024, pp. 1, 3). Collection of annual abundance data has been sporadic; therefore, determination of population trends is difficult. Years of peak abundance are often associated with copious rainfall, especially when storms occur at regular intervals throughout the growing season, whereas years of minimal abundance are typically drought years. The Diversity Database (2024, entire) reports unknown or decreasing trends for the 19 presumed extant occurrences; however, decreasing trends may not be indicative of population status change due to natural fluctuations and sporadic data collection (USFWS, 2024).

**Population Narrative:**

After listing, the number of sites with many individuals decreased, and the number with less than 10 individuals increased. The percentage of sites with fewer than 10 individuals increased by 15 percent between the time of listing and 1994 (USFWS, 2008). The most current occurrence information documents the presence of 18 extant occurrences. Populations exhibit extreme fluctuations in size among years, often varying by one or two orders of magnitude (CNDDB 2013). Individual occurrence sizes ranged over time from fewer than 100 plants to more than 1.5 million plants (CNDDB 2013). Collection of annual abundance data has been sporadic; therefore, determination of population trends is difficult. A 2009 study by Sloop and Ayres found that moderate genetic diversity existed among the occurrences of Blennosperma bakeri on the Santa Rosa Plain (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Development and conversion to agriculture (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

**Stressor:** Alteration of hydrology (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil

moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

**Stressor:** Off-highway vehicles (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Damage by off-highway vehicles was noted as a threat to Blennosperma bakeri. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

**Stressor:** Grazing managment and thatch accumulation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (Phalaris aquatica), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

**Stressor:** Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

**Stressor:** Climate change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including B. bakeri, L. burkei, and L. vinculans. (USFWS< 2016)

**Stressor:** Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Chance events constitute a serious threat to Blennosperma bakeri. Because the known occurrences of B. bakeri are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998). (USFWS, 2016)

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

**Stressor:** Non-native invasive species (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in

inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

**Stressor:** Pesticides (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. The pollinators of Sonoma sunshine are diverse and include the European honeybee (Apis mellifera), four species of generalist native bees, syrphid flies, and most abundantly, the solitary bee (Andrena blennospermatis). The Agency's final biological evaluations determined that all three pesticides are highly toxic to bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Sonoma sunshine, there is a potential for the three pesticides to indirectly adversely affect the species (Agency 2022a, p. 4; Agency 2022b, p. 2; Agency 2022c, p. 3). The Agency anticipates releasing amended proposed interim decisions and a national consultation with the Agency is currently pending. (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
A/1: Eighty percent of extant, native occurrences, not protected as of December 2014, within each core area (Windsor Core Area, Alton Lane Core Area, and Blennosperma bakeri Southern Core Area) are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to preserve isolated and/or genetically unique occurrences. (USFWS, 2016)

A/2: The following additional habitat is needed in order to downlist B. bakeri. New preserves protect a minimum of 50 ac in the Windsor Core Area, a minimum of 500 ac in the Alton Lane Core Area, and a minimum of 300 ac in the Blennosperma bakeri Southern Core Area. These preserves consist of occupied habitat that is not currently protected. The ecological integrity (e.g., water quality, hydrology, uplands conditions) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to Blennosperma bakeri, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future. (USFWS, 2016)

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with native occurrences may be less than 10 ac. The preserves should be as near to new or existing preserves as possible .(USFWS, 2016)

A/4: The total new preserve acreage in core area includes no less than 175 ac of vernal pools and swales in the Alton Lane Core Area, no less than 105 ac in the Blennosperma bakeri Southern Core Area, and no less than 18 ac in the Windsor Core Area. However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: Native occurrences, extant as of December 2014, in (a) the Windsor Core Area, and (b) the Blennosperma bakeri Southern Core Area are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected sites. Extant native occurrences in the Alton Lane Core Area are replicated at 1:2 (tripled) in permanently protected appropriate sites24. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016)

E/2: The preserves noted in Factor A are occupied by Blennosperma bakeri seeds at a density of 2,500 seeds per square meter averaged over whole vernal pools and swales when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and address the effects of small occurrence size, and climate change, among other threats, are developed and are being effectively implemented. (USFWS, 2016)

Recovery Priority Number: 5C

**Delisting Criteria:**
A/1: At least 90 percent of all known native occurrences of Blennosperma bakeri that are extant as of December 2014, have been fully protected in perpetuity. (USFWS, 2016)

A/2: 100 ac of habitat containing Blennosperma bakeri is preserved and appropriately managed in the Sonoma Valley Management Area. (USFWS, 2016)

E/1: In addition to replication noted in E/1 of the downlisting criteria for Blennosperma bakeri, all occurrences in management areas have been replicated at 1:2 at appropriate locations.

Bouverie Preserve, east of the Town of Glen Ellen, may be considered as part of the Sonoma Valley Regional Park Management Area and replicated at 1:2 if Blennosperma bakeri is still found there. This occurrence, if not already lost, could provide important genetic diversity and thus be valuable for the recovery of the species. The occurrences in the Sonoma Valley Management Area should be replicated at 1:3. (USFWS, 2016)

E/2: All replicate occurrences from E/1 have achieved the same rates of seed density (2,500 seeds per square meter), as the core area occurrences. (USFWS, 2016)

E/3: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ including: occurrences in Sonoma Valley Regional Park and the Wood Road area in the northern portion of the Alton Lane core area. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6 of the Recovery Plan. (USFWS, 2016)

**Recovery Actions:**

- 1. Protect extant occurrences and potential habitat for Blennosperma bakeri. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of Blennosperma bakeri including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).
- 3. Collect and store seed from all occurrences of Blennosperma bakeri. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that

seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)

- 4. Survey historical locations and other potential habitat (not previously surveyed) where Blennosperma bakeri may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for Blennosperma bakeri. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on Limnanthes vinculans and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of Blennosperma bakeri, Lasthenia burkei, and Limnanthes vinculans. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for Blennosperma bakeri. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. Blennosperma bakeri and Limnanthes vinculans at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)
- 10. Engage and educate the public about Blennosperma bakeri recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education

and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)

- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)
- Recommendation for future action: In response to the recently discovered range expansion of Sonoma sunshine, the Service recommends surveying vernal pools in Mendocino County near the recent observation of Sonoma sunshine to search for additional occurrences. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Sonoma sunshine. Some of these recommendations have already been discussed in previous recovery documents (Service 2016, pp. 90–99; Service 2019, p. 5) and remain valid. 1. Habitat Acquisition, Management, and Restoration. All sites with Sonoma sunshine present should be protected, managed, and monitored to address recovery goals. Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and large unprotected areas currently occupied by the species should be given the highest priority. Large, formerly occupied sites that are unoccupied but have a high restoration potential should also be considered. Protected lands must also be adequately managed or restored based on the best available science. 2. Determine Population Status. Comprehensive, range-wide surveys should be completed for all known occurrences (both extant and extirpated) recorded in the Diversity Database. The site-specific evaluations should include, at minimum, whether the species is present, estimated population/occurrence extent, extent of suitable habitat, and an indepth analysis of threats at that location. Field surveys for the evaluation should be timed for favorable conditions, such as in the first wet year following a drought. Occurrence reports in the Diversity Database should be updated to represent the most accurate, up-todate population data. These results should be used to help inform decision-makers about the acquisition of appropriate sites where Sonoma sunshine occurs but are unprotected, to suggest sites that could be acquired for restoration, and to develop an adaptive management program that will achieve the recovery of Sonoma sunshine. 3. Monitor Occupied Sites. Known populations of Sonoma sunshine should be monitored during multiple precipitation/drought cycles to gain a better understanding of the ecology of the species and impacts of grazing and community composition. 4. Seed Collection, Research, and Planting.

Collect and correctly store Sonoma sunshine seeds from extant populations found during comprehensive surveys. Seed collection results should be compiled into a list that qualitatively describes the environmental conditions of the collection site and the treatment techniques used. Partner groups should conduct further research on the genetic diversity of seedlings from different occurrences, germination success rate, and replanting success rate. 5. Invasive Species Management. A basic inventory of invasive species should be conducted to itemize, describe, and map the current invasive plants that are the highest threat to the Sonoma sunshine. This inventory would be used as a management tool to prioritize and begin targeting the invasive plants and provide a baseline to evaluate the effectiveness of management actions. Non-native, invasive (noxious) plant species should be controlled and eradicated. Use existing management plans or develop and implement management plans that include control of invasive plants for all protected areas (USFWS, 2024)

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# SPECIES ACCOUNT: *Boltonia decurrens* (Decurrent false aster)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/14/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

**Physical Description**

A robust, short-lived perennial herb, up to 2 m tall, that produces numerous flower heads with white or pale violet ray flowers surrounding a yellow central disk (NatureServe, 2015).

**Taxonomy**

Formerly classified as Boltonia asteroides var. decurrens or B. latisquama var. decurrens; now recognized as a distinct species (B. decurrens) by Flora of North America (2006) and Kartesz (1994), the U.S. Fish and Wildlife Service, and the Illinois and Missouri Heritage Programs (NatureServe, 2015).

**Historical Range**

Historical collection records reveal that Boltonia decurrens once occurred in almost contiguous populations along a 400 km stretch between LaSalle, Illinois and St. Louis, Missouri within the Illinois and Mississippi River floodplain. A disjunct population, reported in 1976, but not found since, is known from Cape Girardeau, MO, about 195 km down the Mississippi River from St. Louis (Schwegman and Nyboer, 1985) (NatureServe, 2015).

**Current Range**

The species is currently limited to disjunct populations from Woodford County, Illinois to Madison County, Illinois. In some years, ephemeral populations occur in St. Charles County, Missouri, in the area of confluence of the Mississippi and Illinois Rivers (NatureServe, 2015). There is no apparent change in the distribution or range of the species. (USFWS, 2020)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual: vegetative, sexual: self-pollination, cross-pollination (NatureServe, 2015)

**Lifespan**

Adult: 1 - 2+ years (USFWS, 2012)

**Breeding Season**

Adult: August - October (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Unshaded soil surface (NatureServe, 2015)

**Reproduction Narrative**

Adult: Vegetative reproduction occurs through shoots formed from a basal rosette (Smith and Keevin 1998). The species is primarily outcrossing, but some selfing occurs (Smith, 1995). Seed production is prolific with an average of ca. 50,000 seeds produced per plant (Smith & Keevin 1998; Smith, 1990). Seedling survival in the field is < 1%. However, under optimal conditions, the average plant produces 40,000 seedlings but the rate of seedling survival is low (Smith & Keevin 1998). Boltonia decurrens blooms from August through October throughout its range (Schwegman and Nyboer, 1985). Germination and seedling establishment do not occur where the soil surface is shaded, such as in places where natural succession has been uninterrupted for a period of 3 - 5 years. Seed germination is also inhibited by silt deposition (NatureServe, 2015). It is considered a perennial plant but also exhibits annual and biennial lifecycles (USFWS, 2012).

**Habitat Type**

Adult: Riparian, wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forested wetland, herbaceous wetland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Disturbance regime, preferably flooding (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Successional vegetation (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 1990)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: It colonizes periodically disturbed riverine moist soil habitats (Smith et al. 2005). In general, sites where the species is successful in reproducing sexually and maintaining a self-sustaining population are characterized by moist, sandy soil and regular disturbance, preferably periodic flooding, which maintains open areas with high light levels. Analysis of 19th-century habitat data taken from herbarium sheets indicates that natural habitat was the shores of lakes and the banks of streams, including the Illinois River. In these habitats, regular flooding prevented succession, allowing sunlight to reach the seedlings. Boltonia decurrens is still found in these occasional natural habitats, but it is now primarily restricted to disturbed lowland areas, where it appears to be dependent on human activities (mowing, cultivation) for survival. Although prolonged flooding by extremely turbid water can damage a population (US Fish and Wildlife Service, 1990), the species is extraordinarily flood tolerant (Stoecker, Smith and Melton, 1995) and is known to survive several months of complete inundation by relatively clear groundwater (Smith, 1990). The palustrine habitat is characterized as forested wetland and herbaceous wetland (NatureServe, 2015). As many as 11 plants have been observed to grow from a single stem of the previous year, giving a 2-year-old wild population a definite clumped appearance (USFWS, 1990).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: It appears that one mechanism of long distance dispersal of B .decurrens seeds is by flood waters. There appears to be suitable habitat for the species in many areas on the flood plain of the Illinois River; however, dispersal has been prevented by the extensive levee system that has been constructed to reduce flood damage to agricultural fields. (USFWS, 1990)

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2020)

**Species Trends:**

Unknown (USFWS, 2020)

**Number of Populations:**

43 (USFWS, 2012)

**Population Size:**

1000 - 10,000 individuals (NatureServe, 2015)

**Population Narrative:**

Like the numbers of populations, numbers of individuals of B. decurrens also fluctuate greatly from year to year. Larger stands sometimes have several thousand plants in good years, occasionally exceeding 10,000. Because of the vulnerability of this species to changes in flooding regime, population number is expected to continue to fluctuate in upcoming years. The short term population trend has been relatively stable to a < 30% decline. Preliminary isozyme data developed by Thomas Ranker (University of Colorado, Boulder) from seeds collected from three populations in Illinois in 1994 indicate that there is a high level of genetic diversity (Smith, 1995). This rare species is much more variable, by all the measures examined, than most rare or geographically-restricted plant species, and is even slightly more variable than the average plant species (NatureServe, 2015). Approximately 43 populations have been discovered and monitored intermittently from 1984 to present. Due to the intermittent nature of the available data, long-term trends are not readily apparent but appear to include a periodical expansion and contraction of populations (USFWS, 2012). Specifically, we cannot draw conclusions about individual populations at the site scale, or the population as a whole, at the species-wide scale. We can confidently say, however, that decurrent false aster was found at least once at more than half of the historically documented sites, and that the number of plants at a site often varied drastically, which is consistent with historical data. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat degradation (NatureServe, 2015 and USFWS, 1990)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Boltonia decurrens is threatened primarily by anthropogenic disturbance of natural habitat. Principal threats include flood-control measures; agricultural use of marginal river-bottom land; increased siltation of floodwater, which decreases light availability and prevents germination and seedling establishment; herbicide use for weed control; and marina construction (NatureServe, 2015). Boltonia decurrens populations may also be vulnerable to destruction by discing and herbicide use in low-lying marginal lands for crop weed control. Nearly all stands are in habitats kept open by occasional cropping (USFWS, 1990).

**Stressor:** Hybridization (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Preliminary allozyme research has been conducted on the potential hybridization of B. decurrens and a related species in the genus, B. asteroides. Hybridization could pose a threat to the species through decreased fertility, genetic swamping, and ecological competition from hybrid individuals (DeWoody 2011). DeWoody et.al. (2011) tested for hybridization in sympatric populations using allozyme genetic marker data. The results revealed a very low rate of hybridization and introgression, indicating that cross-pollination and hybridization may not pose an immediate threat to the species. However, higher resolution genetic testing has yet to be performed, and therefore the level of threat posed by hybridization is currently indeterminable (USFWS, 2012).

**Stressor:** Prolonged flooding (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Prolonged flooding during the growing season appears to be a limiting factor. A flood in 1981 inundated most of the unleveed flood plain of the Illinois River with turbid flood water for an extended period during the summer. Shrubs such as Cephalanthus occidentalis were killed by the prolonged total inundation in some areas, and herbs were buried under heavy deposits of silt. Despite intensive searches, no B. decurrens was found for 2 subsequent seasons along the Illinois River. Such conditions severely limit natural reproduction and survival by B. decurrens (USFWS, 1990). The survey records examined for this review (2012-2018) indicate that many known sites were under water during the fall survey season, which precluded both plant survival and surveys. However, decurrent false aster seeds (“achenes”) remain viable even when buried in the soil for long periods (at least 88 months) of time (Baskin and Baskin 2002). Therefore, late season flood events do not necessarily mean that populations are locally extirpated if suitable growing conditions are present in subsequent years. However, as demonstrated by the population records for the species (see Appendix A) late flooding events on the Illinois River across the range of the species continue to appear to affect population growth, at least in the short term. (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 8

**Delisting Criteria:**
1. A basic research program to determine the requirements of a naturally reproducing population must be completed (USFWS, 2012).

2. Twelve geographically distinct self-sustaining natural or established populations of the species must be protected through purchase in fee, easement, or by cooperative management agreements (USFWS, 2012).

3. Populations must be monitored for a period of five years to determine if they are self-sustaining. Self-sustaining is defined for recovery purposes as a population which is found to be stable or expanding during the five-year monitoring period (USFWS, 2013).

**Recovery Actions:**
- Survey suitable habitat for additional populations (USFWS, 1990).
- Protect existing and established populations (USFWS, 1990).
- Establish new populations (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Monitor natural and established populations (USFWS, 1990).
- Develop and maintain public support (brochure/display) (USFWS, 1990).
- Continue to monitor known B. decurrens sites and search for new populations annually, collecting GPS location and census data. Include survey efforts for B. decurrens in suitable habitat at the confluence of the Illinois River and Mississippi River to determine the extent of the species' southern range (USFWS, 2012).
- Finalize the draft cooperative management agreement between the ILDNR and the Service (USFWS, 2012).
- Establish a consensus among the workgroup regarding the core sub-populations that are important for the survival of the species during times of adverse hydrologic conditions. Also, normal, expected patterns of expansion and contraction of populations over time should be identified to facilitate the definition of population stability in the context of recovery (USFWS, 2012).
- Based on the results of the genetic primer research by Drs. Romano, explore genetic relationships between sub-populations and refine the metapopulation model for the species. Specifically, dispersal patterns and important source populations could be identified through microsatellite research in combination with spatial analysis (USFWS, 2012).
- Explore the phenomenon of hybridization between B. decurrens and B. asteroides using microsatellite genetic markers. Research should include a confirmation of hybridization between the two species and an analysis of the extent of hybridization in the population (USFWS, 2012).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue to monitor known decurrent false aster sites and search for new populations annually, collecting GPS location and census data. Other survey methods, such as remote sensing, should be explored to increase the number of sites that can be surveyed annually. • Establish a consensus among the workgroup regarding the core sub-

populations that are important for the survival of the species during times of adverse hydrologic conditions. Also, normal, expected patterns of expansion and contraction of populations over time should be identified to facilitate the definition of population stability in the context of recovery. • Develop a sampling methodology to ensure comparable annual data (USFWS, 2020).

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# SPECIES ACCOUNT: *Bonamia grandiflora* (Florida bonamia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 12/2/1987; Southeast Region (R4)

**Physical Description**

A perennial vine with appressed hairs and long prostrate stems a meter or more in length. It has a long, relatively slender tap root. The leathery sessile or subsessile leaves are up to 4 cm in length and ovate in shape. The flowers are solitary and sessile in the leaf axils. The funnel-shaped corolla is 7 to 10 cm long and 7 to 8 cm across. It has a deep blue or bluish-purple color with a white throat. The flowers open in the morning and are wilted by early afternoon (G. Romano, University of Florida, personal communication 1996). The fruits are capsules, normally containing four seeds. The seeds are smoothish, pale brown or greenish-brown, 5 to 8 mm long, and oblong (G. Romano, University of Florida, personal communication 1995). The outer face is convex, and the inner two faces are flat, forming an angle (Wunderlin et al. 1980). B. grandiflora is the only morning glory vine found in scrub areas with a large blue flower (Wunderlin et al. 1980), but could be confused with Stylisma villosa. (USFWS, 1999)

**Taxonomy**

Bonamia grandiflora was originally named by Asa Gray in 1880 as Breweria grandiflora. In 1897, Hans Hallier transferred it to the genus Bonamia. There have been no other taxonomic treatments of the species since then (Myint and Ward 1968). (USFWS, 1999)

**Historical Range**

Florida bonamia is found in herbaria with collection locations in Volusia and Marion counties south through Lake, Orange, Polk, Highlands, Hardee, and west to Hillsborough, Manatee, and Sarasota counties (Institute for Systematic Botany 2006). Of these records, three are historical (Sarasota County in 1878, Manatee County in 1916, and Volusia County in 1900) and no recent records exist. (USFWS, 2017)

**Current Range**

The South Florida multispecies Recovery Plan (1999) indicated that Florida bonamia was found in Charlotte, Hardee, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Osceola, and Polk counties in Florida. (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, asexual (USFWS, 1999)

**Lifespan**

Adult: 3 or more years (USFWS, 1999)

**Dependency on Other Individuals or Species**

Adult: Insect pollinators (USFWS, 1999)

**Key Resources Needed for Breeding**

Adult: Fire (NatureServe, 2015)

**Other Reproductive Information**

Adult: Seedling survival rates are not known but are currently being investigated (G. Romano, University of Florida, personal communication 1996). Due to the nature of Bonamia's growth, identifying seedlings from older individuals' stems that are actually connected to other stems below-ground can be difficult. However, it is possible to distinguish these two life phases. Hartnett and Richardson (1989) excavated several plants and found that the clumps of prostrate stems seen at the surface are all connected to a "large central and somewhat woody rootstock." They had no difficulty distinguishing such well-established older individuals from young single-stem plants that had grown from seed. According to Hartnett and Richardson (1989), fire stimulates seed production and germination as well as regrowth from clonal stems. The first season after a fire, clonal stem production is the greatest and then declines. However, seed production is greatest during the second season after a fire. The lag is probably due to the increased energy needed for regrowth following fire; seed production is postponed to conserve energy. New seed production replaces the seed banks that are often destroyed by fire. (USFWS, 1999)

**Reproduction Narrative**

Adult: Bonamia grandiflora grows for 3 or more years (50 FR 42068, Wunderlin et al. 1980), flowering from spring to summer (Small 1933). It has a mixed mating system; it is highly self-compatible, it can self-pollinate, and it can produce seeds without fertilization (G. Romano, University of Florida, personal communication 1998). Pollinators are essential, however, to ensure substantial seed production by self- as well as cross-fertilization. Bonamia grandiflora shows some inbreeding depression in selfed fruits and seeds but it does not appear to be enough to hinder the present populations (G. Romano, University of Florida, personal communication 1998). The seeds of Bonamia become dormant, but may not require dormancy to germinate, particularly if the seeds are planted immediately. Hartnett and Richardson (1989) observed that populations of this species have large seed banks of dormant seeds, mostly within 1 cm of the surface, distributed rather homogeneously, with no relation to the distribution of mature plants. The seedlings germinate throughout the summer until September. The necessity of fire for germination has not been studied; however, germination occurs on sites with sparse vegetation that have not burned recently (G. Romano, University of Florida, personal communication 1996). (USFWS, 1999)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Shrubland/chaparral (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Bonamia grandiflora is a scrub endemic of central Florida. All of its known populations occur within or near scrub or on the edge of scrub habitat in the white sands associated with the ancient Pleistocene dune systems of the central ridge system (Ward 1979). These sands are of the St. Lucie-Paola complex, highly porous, acidic (4.5 to 6.0) and containing few nutrients (Wunderlin et al. 1980). This substrate is associated with a sand pine scrub vegetation consisting of evergreen scrub oak (Quercus myrtifolia and Q. germinata) and sand pine (Pinus clausa) with openings between the trees and shrubs occupied by lichens and herbs. The openings are cleared by infrequent fires or by mechanical disturbance. Bonamia grandiflora is also known to live in disturbed areas near roadways and clearings caused by logging operations (50 FR 42068). This species is not found on altered soils such as the clay applied to logging roads (Miller 1989). As the scrub community reaches maturity, encroachment and shading from overstory pines and oaks cause the decline of this species as well as other associated endemics (Wunderlin et al. 1980). It seems that this species prefers an open canopy in full sunlight in order to avoid competition from the surrounding shrubs. For example, in Ocala NF, the Bonamia grows in a variety of growth stages of sand pine, but flowers profusely only in the open, sunny conditions of regeneration stands, and sparsely if at all in older stands. (USFWS, 1999)

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown

**Dispersal/Migration Narrative**

Adult: Dispersal occurs via biotic and abiotic factors - specific factors are unknown.

***Population Information and Trends***

**Population Trends:**

Declining (NatureServe, 2015)

**Species Trends:**

Declining (USFWS, 2017)

**Resiliency:**

Bonamia grandiflora is a long-lived perennial and can self-pollinate and produce seeds without fertilization, which affords the species some natural ability to withstand year-toyear variation in conditions. The distribution of the species includes 55 populations over 6 counties on lands that are managed for appropriate habitat. Many of these populations are within contiguous tracts of land that provide for connectedness between populations. In one study habitat disturbance (e.g., fire and mechanical) resulted in greater plant density, stem densities, seedling recruitment, flowering, and seed production than in habitat that had not been disturbed recently and that was considered successionally mature (Hartnett and Richardson 1989). Because of the disturbance-dependence of this species, some level of environmental stochasticity may not be detrimental and may actually be beneficial to the species. We believe these characteristics provide the species with sufficient and inherent resiliency (USFWS, 2023).

**Representation:**

Bonamia grandiflora is a scrub and sandhill endemic of central Florida. Because the species occurs in a limited range of habitats in central Florida, it may limit the species ability to adapt to changing conditions and therefore limit its representation. The species’ ability to seed without fertilization and self-pollinate may also limit genetic diversity. However, the self-pollination and setting seeds without fertilization allows the species to persist during times or in areas where additional plants will be unavailable for crosspollination. Bonamia grandiflora has low genetic variability compared to other plants endemic to scrub in Florida, which is likely the result of a small initial gene pool and/or strong selection in the harsh scrub environment (Romano 1999). Habitat fragmentation and population isolation in some cases may contribute to limitations in genetic diversity (Romano 1999). The mode of dispersal is undocumented for this species, but seeds may be dispersed by animals (e.g., herbivores or insects), wind, or water dispersal as seen in other members of the morning glory family (Convolvulaceae; Austin 1997). In one study seed density in the soil of disturbed site (i.e., site was previously disked or plowed) was closely linked to the proximity of adult plants and in other sites (e.g., undisturbed or burned sites) seed density was not related to proximity to adult plants (Hartnett and Richardson 1989). Some of these characteristics may limit the species’ representation but also allow it to persist when there are few nearby plants for cross-pollination. However, we do not feel that these characteristics will impact the species’ viability in the foreseeable future (USFWS, 2023).

**Redundancy:**

As described in the information above, the species is known to occur in 55 managed, secured populations across six counties in the state. In addition to known, managed populations, there are an additional 16 populations on unsecured or unmanaged lands. In addition to the known populations, the species’ condition in Ocala National Forest was described by USFS personnel as “widespread … it is in every scrub stand essentially” (Jay Garcia, USFS pers. comm.). This indicates to the Service that the species is likely much more widespread than we know and may be similarly more widespread on other protected and private lands. Because of the widespread nature of the species and its general biological characteristic, a single catastrophic event is unlikely to impact all individuals in all populations. and should have sufficient redundancy to be viable in the foreseeable future (USFWS, 2023).

**Number of Populations:**

95 (USFWS, 2023)

**Additional Population-level Information:**

Turner et al.'s (2006) assessment included locality records over the past 20 years and more recent observations and it is not evident from this database whether Florida bonamia is still found at each of the 66 locations. Therefore, without a comprehensive range-wide survey it is not possible to evaluate the spatial distribution and trends in spatial distribution of this species. Nonetheless, it is likely that some of the historic locality records on private lands have been lost due to habitat degradation (fire exclusion) and destruction. As a result, since its listing, the distribution of Florida bonamia has likely become more fragmented. (USFWS, 2017)

**Population Narrative:**

The status of Florida bonamia is largely unknown because repeated surveys have not been conducted at most known populations. However, available monitoring suggests that some populations may be in decline and others may be increasing, but this may be reflective of Florida honmnia's typical boom and subsequent decline following fire. Use of periodic prescribed fire appears to be essential in maintaining suitable habitat. Sixty-six locality records existed for Florida bonamia in 2006, but the number of extant populations is not known because recent range wide surveys have not been conducted. Twenty-five locality records occur on public lands. (USFWS, 2017). Bonamia grandiflora formerly occurred in central Florida peninsula counties from Volusia and Marion south to Highlands and Charlotte as shown in Figure 1. (Wunderlin et al. 1980). The Florida Natural Areas Inventory's (FNAI) Element of Occurrence Records (EO) database listed 95 populations from nine counties in 2022 (e.g., Hardee, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Osceola, and Polk). An EO is considered a distinct population that is separated from another EO by a distance of 1 kilometer or greater. When assessing the species, there are currently 55 extant populations in six counties where they occur on managed, conservation lands (e.g., Highlands, Lake, Manatee, Marion, Orange, and Polk). Populations (i.e., EOs) in private ownership, historical EOs, extirpated EOs, or failed to find EOs are not included in the following table (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Fire Suppression (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The most pervasive threat to Florida bonamia on public land is habitat degradation due to fire suppression, although off-road vehicle use on the ONF is likely to result in adverse impacts. Florida bonamia on private lands are also threatened long-term with fire suppression, but habitat destruction is a more immediate concern in many locations. Recent range wide surveys have not been conducted for this species so evaluating threats due to fire suppression and habitat destruction is problematic because in many instances we do not know if previously identified populations still exist. Nonetheless, most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2007; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of Florida bonamia habitat in some areas. Except for several privately owned conservation parcels, most other private landowners are unlikely to use habitat management techniques such as prescribed fire to maintain or enhance Florida bonamia habitat. At present, there are no incentives available that would encourage private landowners to undertake prescribed fire, especially for those who own relatively small parcels embedded in urban matrices. As a result, we believe that many locality records for Florida bonamia on nonconservation parcels in private ownership are threatened with habitat modification due to fire suppression. (USFWS, 2017)

**Stressor:** Urban Development (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Florida bonamia that occur on non-conservation private lands also are vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. Florida bonamia on

each private parcel is vulnerable to this threat at any time, however, we are not aware of any imminent loss of Florida bonamia due to development. (USFWS, 2017)

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Overutlization is not currently thought be a significant risk factor to Florida bonamia; however, TNC reported two occasions of unauthorized plant removal on INC property since 1991 (TNC 2006). (USFWS, 2017)

**Stressor:** Disease or predation (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Florida bonamia may be affected by fungus, but no detailed investigations have been undertaken (Romano 1999). Insect herbivory has been observed, bu t is not thought to be a significant risk to Florida bonamia (Romano 1999). (USFWS, 2017)

**Stressor:** Disease or predation (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Florida bonamia may be affected by fungus, but no detailed investigations have been undertaken (Romano 1999). Insect herbivory has been observed, bu t is not thought to be a significant risk to Florida bonamia (Romano 1999). (USFWS< 2017)

**Stressor:** Inadequacy of existing regulatory mechanisms: Florida (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Existing regulatory mechanisms appear adequate to protect Florida bonamia on State and federally owned lands. Furthermore, we believe Florida bonamia on private conservation parcels are adequately protected because The Nature Conservancy would not authorize removal or destruction of Florida bonamia except for scientific or educational purposes. Even then, we anticipate that TNC would seek research permits from the Service to evaluate potential impacts resulting from proposed research or educational projects involving Florida bonamia. On private properties, Federal or State laws provide little protection for Florida bonamia. Since the majority of extant Florida bonamia populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species. e. Other natural or manmade factors affecting its continued existence: The 1999 South Florida Multi-species Recovery Plan (Service 1999) indicated that competition with non-native vegetation (e.g., cogon grass) may have been a management concern at ONF. Although ONF has an exotic vegetation management program in place, this threat is not entirely controlled and it is possible that unknown bonamia populations within the ONF may be affected by cogon grass or other exotic vegetation. We suspect that there are other locations containing Florida bonamia that also contain exotic vegetation, but we did not find current literature indicating this to be a significant

management problem. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 8

**Delisting Criteria:**
1. The species is secure in Ocala National Forest and low-intensity monitoring must continue after delisting (USFWS, 2008).

2. Secure and monitor at least three sites in Highlands county; three sites in Polk county; and at least two sites in other counties (USFWS, 2008).

3. Provide at least five years of demographic monitoring at each of the sites identified in numbers 1 and 2 (USFWS, 2008).

In South Florida: Delisting can be achieved when: (1) sites, within the historic range of B. grandiflora, are adequately protected from habitat loss, degradation, and fragmentation; (2) when these sites are managed to maintain the seral stage of xeric oak scrub communities to support B. grandiflora; and (3) when monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

**Recovery Actions:**
- Protect habitat through purchase and other means (including the Habitat Conservation Plan process for threatened animals in the Florida scrub habitat) (USFWS, 1996).
- Manage protected habitats (USFWS, 1996).
- Assess progress and plan post-recovery monitoring (USFWS, 1996).
- S1. Determine current distribution of B. grandiflora. Some portions of B. grandiflora's range have been well surveyed (Ocala NF and the southern Lake Wales Ridge), yet a distribution has not been ascertained for this species. Lack of survey knowledge in much of its range makes defining distribution difficult. (USFWS, 1999)
- S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- S3. Conduct research on life history characteristics of B. grandiflora. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed.
- S4. Monitor existing populations of B. grandiflora. Develop monitoring protocol to assess population trends for B. grandiflora. Develop a quantitative description of the population structure of B. grandiflora. (USFWS, 1999)

- S5. Provide public information about B. grandiflora. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of B. grandiflora and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999) (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- Recommendation for Future Action from 2017 5-Year Review: Revise the recovery criteria to establish measureable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, and the demographic performance levels/rates that should be met. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: A range wide survey should be conducted to determine the size and location of extant Florida bonamia populations and assessment of historic locality records. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Demographic monitoring of Florida bonamia populations should be initiated on public lands. Level 2 monitoring (Menges and Gordon 1996) includes sufficient detail to evaluate trends in population status over time. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Management activities should be implemented on public lands that contain Florida bonamia, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: An assessment of mechanical vegetation management (e.g., roller chopping, mowing, gyro-tracking, logging, and chain-saw felling) is needed to evaluate the response of Florida bonamia to various management alternatives. These data should be collected concurrently with level 2 monitoring. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Future land acquisition or other conservation measures should be taken to protect large Florida bonamia populations on unprotected lands. Protection should target bonamia populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Given the relatively large number of unprotected Florida bonamia populations, efforts should be explored to encourage private landowners to conserve and manage property known to contain this species.

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence wherever additional opportunities present themselves. • Encourage landowners whose populations are under a habitat management plan to monitor occupied habitat for increased data of long-term trends (USFWS, 2023).

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# SPECIES ACCOUNT: *Brickellia mosieri* (Florida brickell-bush)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/6/2014; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Brickellia mosieri is a perennial herb. Mature plants are 0.3–1.1 meters (m) (1.0–3.5 feet (ft)) tall, slender, erect, and branching (Chafin 2000, page numbers not applicable). Leaves are 1–3 centimeters (cm) (0.4–1.2 inches (in)) long, alternate, narrow, linear, thick, usually spreading or curved downward, entire or slightly toothed, and resin dotted. The flower heads are in loose, open clusters at the ends of branches. Disk flowers are white in small, dense heads surrounded by hairy, slightly ribbed bracts; there are no ray flowers, although long-style branches (white, sometimes brown) may appear to be rays. (USFWS, 2013)

**Taxonomy**

Brickellia mosieri (Family: Asteraceae) was first described by Small in 1933 as Kuhnia mosieri. In 1970, Long called the species Kuhnia eupatorioides var. floridana, reducing it to a variety of a more widespread species occurring in the eastern United States. In 1971, Shinners included all members of the genus Kuhnia in Brickellia and restored the plant to species status, calling it Brickellia mosieri (USFWS, 2013). Kartesz (1999) lists B. mosieri as a synonym of Brickellia eupatorioides var. floridana. (NatureServe, 2015).

**Historical Range**

Brickellia mosieri is endemic to the pine rocklands of the Miami Rock Ridge in Miami-Dade County. It was historically known from central and southern Miami-Dade County from approximately Coconut Grove to Florida City, a range of approximately 45.0 km (28.0 mi), along the Miami Rock Ridge. (USFWS, 2014). The historical range of Florida brickell-bush is central and southern Miami-Dade County, covering approximately 22.5 miles (36.2 km) from South Miami to Florida City (Bradley and Gann 1999). At present, the northernmost extant population occurs at Ron Ehmann Park (10 miles south of the northernmost historic range) with the southern extent occurring in Florida City at Navy Wells Pineland Preserve (USFWS, 2023).

**Current Range**

Brickellia mosieri is currently distributed from central and southern Miami-Dade County from SW 120 St. to Florida City, suggesting its historical range has contracted at least 13.6 km (8.5 mi), or more than 30 percent. (USFWS, 2014). The historical range of Florida brickell-bush is central and southern Miami-Dade County, covering approximately 22.5 miles (36.2 km) from South Miami to Florida City (Bradley and Gann 1999). At present, the northernmost extant population occurs at Ron Ehmann Park (10 miles south of the northernmost historic range) with the southern extent occurring in Florida City at Navy Wells Pineland Preserve (USFWS, 2023).

**Critical Habitat Designated**

Yes; 9/16/2015.

**Legal Description**

On August 17, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 16, 2015) for Brickellia mosieri (Florida brickell-bush) under the

Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Florida (80 FR 49846-49886).

**Critical Habitat Designation**

The critical habitat designation for Brickellia mosieri includes six CHUs (40 sub-units) in Miami-Dade County, Florida. This species critical habitat encompasses approximately 2,624 acres (ac) (1,062 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 49846-49886).

Unit BM1: Trinity Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit BM1 consists of 18 ha (43 ac) in Miami-Dade County. Within Unit BM1, there are two subunits—BM1A (Countyowned) and BM1B (combination of State, County, and privately owned lands). The unit is comprised of State lands within Trinity Pineland County Park (4 ha (10 ac)); County lands primarily within A. D. ‘‘Doug’’ Barnes Park (6 ha (14 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 24 Street, on the south by the Snapper Creek Expressway (State Road (SR) 878), on the east by SW 67 Avenue, and on the west by SW 87 Avenue.

Unit BM2: Nixon Smiley Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit BM2 consists of approximately 108 ha (267 ac) of habitat in MiamiDade County. Within Unit BM2, there are seven subunits (BM2A–BM2G) comprising primarily conservation lands and including four larger areas plus three smaller areas. The unit is comprised of State lands within Camp Matecumbe, Tamiami Pineland Complex Addition, and Rockdale Pineland (49 ha (121 ac)); County/local lands primarily within Nixon Smiley Pineland Preserve, Tamiami #8 (Nixon Smiley Addition) Pineland, Pine Shore Pineland Preserve, Ron Ehman Park, and Rockdale Pineland Addition (59 ha (146 ac)); and small portions of parcels in private or other ownership (less than 1 ha (less than 1 ac)). This unit is bordered on the north by SW 104 Street, on the south by SW 152 Street (Coral Reef Drive), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit BM3: USDA Subtropical Horticultural Research Station and Surrounding Areas, Miami-Dade County, Florida: Unit BM3 consists of approximately 127 ha (315 ac) of habitat in MiamiDade County. Within Unit BM3, there are eight subunits (BM3A–BM3H), including two larger areas (U.S. Department of Agriculture (USDA) Subtropical Horticultural Research Station, and Deering Estate at Cutler) plus six smaller areas surrounding these. The unit is comprised of Federal lands within the USDA Subtropical Horticultural Research Station (59 ha (145 ac)); State lands within the R. Hardy Matheson Preserve, Ludlam Pineland, Deering Estate at Cutler, and Deering Estate South Addition (45 ha (112 ac)); County/local lands within Coral Reef Park, Ned Glenn Nature Preserve, and Bill Sadowski Park (15 ha (38 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 112 Street, on the south by the intersection of Old Cutler Road and Franjo Road (County Road (CR) 977), on the east by the Atlantic Ocean, and on the west by U.S. 1 (South Dixie Highway).

Unit BM4: Richmond Pinelands and Surrounding Areas, Miami-Dade County, Florida: Unit BM4 consists of approximately 395 ha (975 ac) in Miami-Dade County. Within Unit BM4, there are eight subunits (BM4A–BM4H), most within the Richmond Pinelands complex (made up of Federal and County-owned lands, as well as land owned by the University of Miami). The unit is comprised of Federal lands owned by the USCG (Homeland Security), U.S. Army Corps of

Engineers (ACOE; Department of Defense), U.S. Prison Bureau (Department of Justice), and the U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA) (75 ha (185 ac)); County/local lands within and adjacent to Larry and Penny Thompson Park, Martinez Pineland, Zoo Miami, and Eachus Pineland (239 ha (590 ac)); and parcels in private or other ownership (81 ha (200 ac)). This unit is bordered on the north by SW 152 Street (Coral Reef Drive), on the south by SW 200 St (Quail Drive/SR 994), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit BM5: Quail Roost Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit BM5 consists of approximately 96 ha (238 ac) in Miami-Dade County. Within Unit BM5, there are 11 subunits (BM5A–BM5K), including 4 larger areas plus 7 smaller areas surrounding these. The unit is comprised of State lands within Quail Roost Pineland, Goulds Pineland and Addition, and Silver Palm Groves Pineland (39 ha (97 ac)); County/ local lands including Black Creek Forest, Rock Pit #46, and lands owned by the School Board of Miami-Dade County (15 ha (37 ac)); and parcels in private ownership (42 ha (104 ac)), including Porter-Russell Pineland owned by the Tropical Audubon Society. This unit is bordered on the north by SW 200 St (Quail Drive/SR 994), on the south by SW 248 Street, on the east by the Florida Turnpike, and on the west by SW 194 Avenue.

Unit BM6: Camp Owaissa Bauer and Surrounding Areas, Miami-Dade County, Florida: Unit BM6 consists of approximately 112 ha (276 ac) of habitat in MiamiDade County. Within Unit BM6, there are 12 subunits (BM6A–BM6L), composed of 1 larger area (Camp Owaissa Bauer and its addition) and 11 smaller areas to the south. The unit is comprised of State lands within Owaissa Bauer Pineland Addition, Ingram Pineland, West Biscayne Pineland, and Fuchs Hammock Addition (20 ha (50 ac)); County/local lands including Camp Owaissa Bauer, Pine Island Lake Park, Seminole Wayside Park, and Northrop Pineland (63 ha (156 ac)); and parcels in private ownership (28 ha (70 ac)), including the private conservation area, Pine Ridge Sanctuary. This unit is bordered on the north by SW 248 Street, on the south by SW 312 Street, on the east by SW 112 Avenue, and on the west by SW 217 Avenue.

Unit BM7: Navy Wells Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit BM7 consists of approximately 206 ha (510 ac) of habitat in MiamiDade County. Within Unit BM7, there are eight subunits (BM7A–BM7H), including one larger area (Navy Wells Pineland Preserve) and seven smaller outlying areas. The unit is comprised of State lands within Palm Drive Pineland, Navy Wells Pineland #39, Navy Wells Pineland Preserve (portion), and Florida City Pineland (53 ha (132 ac)); County/ local lands including primarily Sunny Palms Pineland and Navy Wells Pineland Preserve (portion) (125 ha (309 ac)); and parcels in private ownership (28 ha (68 ac)). This unit is bordered on the north by SW 320 Street, on the south by SW 368 Street, on the east by U.S. 1 (South Dixie Highway), and on the west by SW 217 Avenue.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Brickellia mosieri critical habitat consists of three components (80 FR 49846-49886):

(i) Areas of pine rockland habitat that contain: (A) Open canopy, semi-open subcanopy, and understory; (B) Substrate of oolitic limestone rock; and (C) A plant community of predominately native vegetation that may include, but is not limited to: (1) Canopy vegetation dominated by Pinus elliottii var. densa (South Florida slash pine); (2) Subcanopy vegetation that may include, but is not limited to, Serenoa repens (saw palmetto), Sabal palmetto (cabbage palm), Coccothrinax argentata (silver palm), Myrica cerifera (wax myrtle), Myrsine floridana (myrsine), Metopium toxiferum (poisonwood), Byrsonima lucida (locustberry), Tetrazygia bicolor (tetrazygia), Guettarda scabra (rough velvetseed), Ardisia escallonioides (marlberry), Psidium longipes (mangroveberry), Sideroxylon salicifolium (willow bustic), and Rhus copallinum (winged sumac); (3) Short-statured shrubs that may include, but are not limited to, Quercus pumila (running oak), Randia aculeata (white indigoberry), Crossopetalum ilicifolium (Christmas berry), Morinda royoc (redgal), and Chiococca alba (snowberry); and (4) Understory vegetation that may include, but is not limited to: Andropogon spp.; Schizachyrium gracile, S. rhizomatum, and S. sanguineum (bluestems); Aristida purpurascens (arrowfeather threeawn); Sorghastrum secundum (lopsided Indiangrass); Muhlenbergia capillaris (hairawn muhly); Rhynchospora floridensis (Florida white-top sedge); Tragia saxicola (pineland noseburn); Echites umbellata (devil's potato); Croton linearis (pineland croton); Chamaesyce spp. (sandmats); Chamaecrista deeringiania (partridge pea); Zamia integrifolia (coontie); and Anemia adiantifolia (maidenhair pineland fern).

(ii) A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat described in paragraph (2)(i) of this entry.

(iii) Habitats that are connected and of sufficient area to sustain viable populations of Brickellia mosieri in the pine rockland habitat described in paragraph (2)(i) of this entry.

**Special Management Considerations or Protections**

When designating critical habitat, the Service assesses whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of Brickellia mosieri and may require special management considerations or protection to reduce threats related to habitat loss, fragmentation, and modification primarily due to development; inadequate fire management; nonnative, invasive plants; and sea level rise. Destruction of the pinelands for economic development has reduced pine rockland habitat on the Miami Rock Ridge outside of ENP by over 98 percent, and remaining habitat in this area is highly fragmented. Brickellia mosieri occurs on a mix of private and publicly owned lands, only some of which are managed for conservation. Populations of the plants that occur on private land or non-conservation public land are vulnerable to habitat loss, while populations on conservation lands are vulnerable to the effects of habitat degradation if natural disturbance regimes are disrupted (e.g., through inadequate fire management). Prolonged lack of fire in pine rockland typically results in succession to rockland hammock, and displacement of native species by invasive, nonnative plants often occurs. Further development and degradation of pine rocklands increase fragmentation and decrease the conservation value of the remaining functioning pine rockland habitat. In addition, pine rocklands are expected to be further degraded and fragmented due to anticipated sea level rise, which would fully or partially inundate some pine rocklands along the coast and in the southern portion of Miami-Dade County (near Navy Wells Pineland Preserve), and cause increases in the salinity of the water table and soils resulting in vegetation shifts in additional pine rocklands across the Miami Rock Ridge. Many existing pine rockland fragments are also projected to be developed for housing as the human population grows and adjusts to changing sea levels. Special management considerations and protections that will address these threats include increased coordination and conservation of these plants and their habitat on Federal lands, and improved habitat restoration and management efforts (including fire management and nonnative plant treatments) of high-priority and high-elevation sites. (USFWS, 2013)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2014)

**Breeding Season**

Adult: August - October (USFWS, 2014)

**Key Resources Needed for Breeding**

Adult: Fire (USFWS, 2014)

**Reproduction Narrative**

Adult: While specific pollinators or dispersers are unknown, flower morphology suggests this species may be pollinated by butterflies, bees, or both (Koptur 2013, pers. comm.); wind is one likely dispersal vector (Gann 2013b, pers. comm.). (USFWS, 2014). Reproduction is sexual (Bradley and Gann 1999, p. 12). Flowering takes place primarily in the fall (August–October) (Bradley and Gann 1999, p. 12). Off-season flowering is usually the result of fire, and B. mosieri will flower within 1 to 2 months following a fire, regardless of the time of year (Possley 2013 pers. comm.) (USFWS, 2014).

**Habitat Type**

Adult: Terrestrial (USFWS, 2014).

**Habitat Vegetation or Surface Water Classification**

Adult: Pine rockland (USFWS, 2014)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Scattered (USFWS, 2014)

**Environmental Specificity**

Adult: Very narrow

**Habitat Narrative**

Adult: Grows exclusively in pine rockland (USFWS, 2014). Pine rockland is characterized by an open canopy of South Florida slash pine (Pinus elliottii var. densa). Subcanopy development is rare in well-maintained pine rocklands, with only occasional hardwoods, such as Lysiloma latisiliquum (wild tamarind) and Quercus virginiana (live oak) growing to tree size in Miami Rock Ridge pinelands (Snyder et al. 1990, p. 253). The shrub/ understory layer is a diverse mix of species including both temperate and tropical shrubs and palms. The pine rocklands where Brickellia mosieri occurs are characterized by an open shrub canopy of Serenoa repens (saw palmetto), Myrica cerifera (wax myrtle), Metopium toxiferum (poisonwood), and Sideroxylon salicifolium (willow bustic) as well as species with more restricted distribution within pine rocklands including Sideroxylon reclinatum ssp. austrofloridense (Everglades bully), Callicarpa americana (beauty berry), Dodonaea angustifolia (varnish leaf), and Ilex cassine (dahoon holly) (Snyder et al. 1990, p. 254; Bradley and Gann 1999, p. 12). Populations are typically sparse and contain a low density of plants even in well-maintained pine rockland habitat (Bradley and Gann 1999, p. 12) (USFWS, 2014). The environmental specificity of this species is very narrow, as it is known only from pine rockland habitat in southern Florida, requiring fire to maintain the openings in which the plant occurs (NatureServe, 2015).

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (USFWS, 2014)

**Dispersal/Migration Narrative**

Adult: Wind is one likely dispersal vector (Gann 2013b, pers. comm.) (USFWS, 2014).

***Population Information and Trends***

**Population Trends:**

50% decline (USFWS, 2013)

**Species Trends:**

50 - 70% decline (NatureServe, 2015)

**Number of Populations:**

55 Historic and 14 Extant populations (USFWS, 2023)

**Population Size:**

All extant populations are estimated to have <1,000 individuals (USFWS, 2023).

**Population Narrative:**

Florida brickell-bush is a perennial herb that is endemic to pine rockland habitat outside of Everglades National Park in Miami-Dade County, Florida. There are 14 known extant populations, all with relatively small population estimates (<1,000). Of the 14 extant populations, one is on federal lands, one is on private lands, eight are Miami-Dade County owned, and four are on State of Florida land managed by Miami-Dade County. The status of 24 historic occurrences is unknown due to inaccessibility. There are 17 known extirpated occurrences of the species. Although the known extant populations occur mostly on county owned lands that are offered some protections, most of the data deficient occurrences are found on privately owned parcels that do not offer sufficient protection to the species (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The pine rockland community of south Florida, to which the species endemic, is critically imperiled globally (FNAI 2012, p. 27). Since the 1800s, residential and commercial development and agriculture have drastically reduced the habitat for these plants throughout pine rocklands in south Florida. Habitat loss continues to occur in its range, and most remaining suitable habitat has been negatively altered by human activity. Another human-related factor that can modify public and private lands alike is the potential for high levels of nutrients from agricultural and urban areas to enter into pine rockland systems. Such chemical alteration of pine rockland soil, which has naturally low amounts of phosphorus and nitrogen, can result in changes to vegetation composition and structure, at the expense of pine rockland endemics such as Brickellia mosieri. Effects of fragmentation on pollinators may include changes to the pollinator community as a result of limitation of pollinator-required resources (e.g., reduced availability of rendezvous plants, nesting and roosting sites, and nectar/pollen); these changes may include changes to pollinator community composition, species abundance and diversity, and pollinator behavior (Rathcke and Jules 1993, pp. 273–275; Kremen and Ricketts 2000, p. 1227; Harris and Johnson 2004, pp. 30– 33). As a result, plants in fragmented habitats may experience lower visitation rates, which in turn may result in reduced seed production of the pollinated plant (which may lead to reduced seedling recruitment), reduced pollen dispersal, increased inbreeding, reduced genetic variability, and ultimately reduced population viability (Rathcke and Jules 1993, p. 275; Goverde et al. 2002, pp. 297–298; Harris and Johnson 2004, pp. 33–34). Exclusion of fire for approximately 25 years will likely result in gradual hammock development over that time period, leaving a system that is very fire resistant if additional pre-fire management (e.g., mechanical hardwood removal) is not undertaken. Now, natural fires are unlikely to occur or are likely to be suppressed in the remaining, highly fragmented pine rockland habitat. The suppression of natural fires has reduced the size of the areas that burn, and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Without fire, successional climax from pine rockland to rockland hammock is rapid, and displacement of native species by invasive nonnative plants often occurs. Understory plants such as Brickellia mosieri are shaded out by hardwoods and nonnatives alike (USFWS, 2013).

**Stressor:** Nonnative plants (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of Brickellia mosieri to some degree (Bradley and Gann 1999, pp. 15, 72; Bradley and Gann 2005, page numbers not applicable; Bradley 2007, pers. comm.; Bradley and van der Heiden 2013, pp. 12–16). As a result of human activities, at least 277 taxa of nonnative plants have invaded pine rocklands throughout south Florida (Service 1999, p. 3–175). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for Brickellia mosieri which responds positively to open conditions (USFWS, 2014).

**Stressor:** Small isolated populations (USFWS, 2013)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Only small and fragmented occurrences of this plant remains. The current range spans such a small area that all populations could be affected by a single event (e.g., hurricane). Although robust population viability analyses (including minimum viable population calculations) have not been conducted for these plants, indications are that most existing populations for this plant are at best marginal (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drier conditions and increased variability in precipitation associated with climate change are expected to hamper successful regeneration of forests and cause shifts in vegetation types through time (Wear and Greis 2012, p. 39). Although it has not been well studied, existing pine rocklands have probably been affected by reductions in the mean water table. Climate changes are also forecasted to extend fire seasons and the frequency of large fire events throughout the Coastal Plain (Wear and Greis 2012, p. 43). While restoring fire to pine rocklands is essential to the long-term viability of Brickellia mosieri populations, increases in the scale, frequency, or severity of wildfires could have negative effects on this species considering its general vulnerability due to small population size, restricted range, few colonies, and relative isolation (USFWS, 2013).

***Recovery***

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

Recovery Priority Number: 5

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

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

***Conservation Measures and Best Management Practices:***
- RECOMMENDED FUTURE ACTIVITIES During this status review, we have utilized the recovery outline and also identified additional potential recovery activities which are included below. Recovery Activities • Implement, continue, or increase habitat restoration efforts (exotic species removal and prescribed fire) at all occurrences. • Pursue conservation agreements and/or acquire land where Florida brickell-bush occurs. • Continue to work with Miami Dade County to protect remnant patches of habitat. • Expand work on ex situ propagation and seed banks. • Support and expand upon the Connect to Protect imitative promoting Florida brickell-bush within its historical range. • Develop a reintroduction plan and conduct reintroduction and augmentation of the species in suitable pine rockland habitat and evaluate reintroduction techniques and success. Monitoring/Research Activities • Survey sites that have an undetermined population status if landowners allow access. • Census extant populations every three years. In the event of fire in a

population, conduct quarterly monitoring up to 2 years post-fire, noting any seedling recruitment. • Conduct demographic research including population assessments, such as phenology and lifeclass stage, population trends, and examining growth and establishment rates. • Conduct reintroduction feasibility studies and identify potential recipient sites. • Conduct research to examine the effects of growing season burns versus non-growing season burns on flowering, seed set, and establishment. • Evaluate how climate change may impact the species range. • Conduct genetic studies to examine diversity among sites that may be declining due to isolation and genetic drift. Outreach Activities • Promote additional partnerships to share information, conduct collaborative research on pine rockland and scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Attend relevant community events that will create and foster appreciation for endemic species in the pine rockland habitat (USFWS, 2023).

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# SPECIES ACCOUNT: *Callirhoe scabriuscula* (Texas poppy-mallow)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/12/1981; Southwest

**Physical Description**

A perennial herbaceous plant found in deep, loose, sandy soils near the Colorado River in west Texas. The fleshy taproots extend about 45 centimeters (cm) (18 inches (in)) deep before branching. During the winter, the plants form rosettes of 3 to 8 basal leaves that have 3 to 5 palmately-arranged lobes. Flower stalks emerge in the spring, reaching up to 45 cm (18 in) tall. The stems and leaves have a rough texture due to a covering of stellate pubescence (star-shaped hairs). Flowers have 5 reddish-purple petals, about 3.8 cm (1.5 in) long, arranged in the form of a cup, with dark maroon centers. This species is distinguished from others in the Genus by its linear involucellar bractlets, valvate calyx lobes that form an apiculate or acuminate point in bud (cover photograph), indehiscent mericarps, stiffly erect stems, and 6- to 8-rayed stellate hairs. (USFWS, 2019a)

**Taxonomy**

Robinson (1895–1897, p. 302) described Callirhoe scabriuscula as a new species in the Malvaceae (Mallow Family), based on a single specimen collected by Dr. Sutton Hayes. Robinson distinguished this from other species in the genus by its densely pubescent carpels with short beaks and involucel of 3 linear bractlets (figure 1.e.a). Callirhoe leiocarpa (tall poppymallow) and C. involucrata (winecup) occur near C. scabriuscula. These are distinguished by smaller flowers with white petal bases and the absence of stellate pubescence; additionally, C. leiocarpa is an annual species and lacks an involucel, and C. involucrata has a prostrate rather than erect habit. (USFWS, 2019a)

**Historical Range**

Historically known from Runnels County, Texas.

**Current Range**

In four counties in Texas: Runnels, Coke, Mitchell, and Scurry. (USFWS, 2019a)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: short-lived perennial (USFWS, 2019a)

**Breeding Season**

Adult: Flowers from late April to mid-June (USFWS, 2019a).

**Key Resources Needed for Breeding**

Adult: Insects for pollination (USFWS, 1985).

**Reproduction Narrative**

Adult: Texas poppy-mallow flowers from late April until mid-June (Amos 1979, pp. 8–10; USFWS 1985, pp. 7–9). Flowers open 2 to 3 hours after sunrise and close before sunset. If pollinated, flowers close within 30 to 90 minutes. Un-pollinated flowers continue to open for 6 to 8 days. Anthers of individual flowers mature prior to stigmas (figure 1.d), releasing their pollen about 36 hours before stigmas emerge. Less than 1 percent of flowers from which insects were excluded produced seeds. Conversely, 85 percent of open-pollinated flowers produced seeds; therefore, Texas poppy-mallow is a predominantly out-crossing species. Plants produced an average of 41.4 fruits per plant per year, and fruits averaged 19 seeds each; thus, individuals produced an average of 878 seeds per year. Three species of bees, Diadasia afflicta, Melissodes intorta, and M. tepanica, forage for nectar and pollen in Texas poppy-mallow flowers and use the staminal column as a landing and take-off platform; the foraging behaviors of these bees indicates that they are likely to be effective pollinators. D. afflicta and M. intorta are oligolectic species that forage primarily within the genus Callirhoe. Seeds mature and dehisce from 10 to 18 days after flowering and fertilization. Flowering ceases by late June, as the weather becomes increasingly hot and dry, and the stems die by late July. New rosettes emerge from the taproots in late August and September. (USFWS, 2019a)

**Habitat Type**

Adult: Terrestrial (USFWS, 2019a)

**Habitat Vegetation or Surface Water Classification**

Adult: Grasslands, shin oak shrublands, or open oak or mesquite woodlands (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Deep sandy soil blown from alluvial deposits along the Colorado River (USFWS, 2019a)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 2019a)

**Habitat Narrative**

Adult: Texas poppy-mallow occurs in deep, loose sands of the Tivoli and Brownfield Soil Series (USFWS 1985, pp. 3–4). These sands are carried by wind from alluvial formations in the Colorado River flood plain and deposited on the lee (north and east) side of the river (USDA Soil Conservation Service 1970, p. 26). The difference between Tivoli and Brownfield soils is that the former lacks a distinct B horizon, while the latter has a sandy clay subsoil at a depth of about 0.51–1.02 m (20–40 in). Dunes up to 9 m (30 ft) high and 61 m (200 ft) wide form to the lee of cultivated fields. These soils have very rapid rainfall infiltration rates, very little runoff, and low water holding capacity. Cruze (1991, pp. 12, 15) found 159 Texas poppy-mallow plants within an area of 225 m2 (2,422 ft2) at the study site at EO3. About 80 percent of Texas poppy-mallow plants occurred on 1-m2 (10.76 ft2) plots that had from 3 to 16 percent cover of forbs and grasses; 79 percent of plots were within this range of vegetative cover (p. 12). This demonstrates that occupied habitats have sparse vegetative cover . (USFWS, 2019a)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Cruze (1991) investigated the soil seed reserve of the Runnels County population mentioned above (EO3). She recovered 325 seeds from 6,583 soil samples totaling 1.7 m3 (60.0 ft3 ) of soil (pp. 6, 9). Seed distribution was uneven, with 91 percent of recovered seeds in the uppermost 5 cm of the soil; 85 percent of seeds were found within 1 m (3.28 ft) in horizontal distance of an established individual (pp. 9–11), indicating that seeds have very limited dispersal. Seed viability, tested with tetrazolium chloride, was 16.3 percent (p. 12); on this basis, the author concluded that seed viability declines rapidly in the soil (p. 19). (USFWS, 2019a)

***Population Information and Trends***

**Population Trends:**

Not available.

**Species Trends:**

Not available.

**Number of Populations:**

10 (USFWS, 2019a)

**Population Size:**

Approximately 2800 individuals (USFWS, 2019a)

**Minimum Viable Population Size:**

1,300 mature, reproductive individuals (USFWS, 2019a)

**Population Narrative:**

The Texas Natural Heritage Program conducted extensive surveys for Texas poppy-mallow from 1987 through 1989 at 143 sites in 37 counties (Poole (1990). This project documented 9 new populations at 6 sites in Runnels, Coke, and Mitchell counties, totaling 2,817 individuals, and reported an additional population discovered in Coke County in 1990 by an environmental consultant (Poole 1990, pp. 1, 3). All populations were found in areas of intact native vegetation on deep, loose, sandy soils of the Tivoli and Brownfield Series near the Colorado River (note that Likes and Heatly are alternate names for the Tivoli and Brownfield soil map units, respectively). The species has now been documented in four counties—Runnels, Coke, Mitchell, and Scurry (Amos 2008, 2019). The most recent censuses (TXNDD 2019) for all known EOs totals less than 3,000 individuals; however, we have no survey data more recent than 2001. All known populations of Texas poppy-mallow occur in Tivoli (Likes) and Brownfield (Heatly) fine sands (NRCS 2019c) in Runnels, Coke, Mitchells, and Scurry counties. Although we do not have geographic data for populations in Scurry County, Amos (2008, 2019) confirmed that at least one population extends from northern Mitchell County into southern Scurry County. The known populations span a linear distance of about 155 km (96 mi) from northwest to southeast. Within the counties mentioned, NRCS (2019c) classifies 16,987 ha (41,975 ac) as Tivoli (Likes) or Brownfield (Heatly) fine sands. (USFWS, 2019a)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 1981)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Much of the natural habitat of Callirhoe scabriuscula has been disturbed. The present-range is limited to one Texas county, much of which is no longer suitable habitat for the plant. The actual area covered by the plant is very small. The range is dissected by a four-lane divided highway (Highway 67) and two frontage roads. All of the land on which the plants now occur is in private ownership. Cultivation, establishment of rural residences, and development of roads and a railway have reduced the range and the size of the populations. An imminent threat to all existing populations is commercial sand mining within the plant's habitat (USFWS, 1981).

**Stressor:** Overutilization (USFWS, 1981)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** If exact localities were published, the plant’s conspicuous and showy blooms could cause it to be threatened by amateur gardeners wildflower enthusiasts, and commercial horticultural collecting. Since all the populations occur on privately owned land, taking of these attractive plants could not be prohibited (USFWS, 1981).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction; however, the known populations of Texas poppy-mallow occur almost entirely on privately-owned land (as well as a small amount of state highway ROW). Federally-listed plants occurring on private lands have limited protection under the ESA, unless they are protected by state laws; the State of Texas also provides very little protection to listed plant species on private lands. It is reasonable to assume that any undiscovered populations are also likely to be privately owned. Therefore, none of the species’ populations and habitats are subject to federal protection unless there is a federal nexus, such as provisions of the Clean Water Act, or a federally-funded project, for example, a new highway or water treatment plant. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally listed with these statuses. The State of Texas listed Texas poppy-mallow as endangered on April 29, 1983. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. Texas Parks and Wildlife Department requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to state endangered species regulations, other state laws may apply. For example, state law prohibits the destruction or removal of any plant species from state lands without a Texas Parks and Wildlife Department permit. (USFWS, 2019a)

**Stressor:** Demographic and genetic consequences of small population sizes (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Small populations are less able to recover from losses caused by random fluctuations in recruitment (demographic stochasticity) or variations in rainfall (environmental stochasticity) (Shaffer and Stein 2000, pp. 308-310). In addition to population size, it is likely that population density also influences population viability, since successful sexual outcrossing—necessary to maintain genetic diversity in populations—requires genetically distinct individuals to be in sufficiently close proximity for cross-pollination to occur. Small, reproductively isolated populations are also susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding depression. The combined demographic and genetic consequences of small population sizes may reduce population recruitment, leading to an extinction vortex of even smaller populations, greater isolation, decreasing genetic diversity, and loss of viability. These factors may already have contributed to the restriction of Texas poppy-mallow to its current state of extreme endemism in the Tivoli (Likes) and Brownfield (Heatly) sands along the Colorado River of Texas. (USFWS, 2019a)

***Recovery***

**Reclassification Criteria:**
1. Texas poppy-mallow is documented in 10 or more protected, viable populations, with at least 3 viable populations in each of 3 recovery units. Populations and metapopulations are delineated by unpopulated gaps of at least 1 km (0.6 mi). However, viable populations that expand and merge with other populations may be counted as separate populations for the specific purpose of meeting this criterion. (USFWS, 2019b)

2. Viable populations have 1,600 or more mature individuals. Mature individuals have flowered at least once or are judged capable of flowering. Population surveys should be conducted during the peak of flowering and fruiting, from April through June. (USFWS, 2019b)

3. Protected populations occur on lands that are legally protected and managed to conserve the Region's native flora and fauna, including Texas poppy-mallow, its habitats, and its pollinators. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, publicly-owned land managed for conservation purposes, and legally binding long-term management agreements with private landowners. (USFWS, 2019b)

Recovery Priority Number: 5C

**Delisting Criteria:**
1. Periodic monitoring indicates that the downlisting criteria have been met, and that demographic trends have subsequently remained stable or have increased over a period of 25 years. Ideally, monitoring (censuses) of each protected population should be conducted during years of above-average April–May rainfall; trend detection should be based on the largest populations observed during each 5-year period. (USFWS, 2019b)

**Recovery Actions:**
- Manage presently known individuals and habitat for maintenance and expansion of existing wild populations.. A crucial step in recovery is to protect existing populations and the habitat upon which they depend. All populations are threatened by expansion of commercial sand mining and development. The land presently inhabited by the Texas

poppy-mallow is under private ownership. The Endangered Species Act is most effective in protecting populations on Federal lands. Immediate protection of the habitat and cooperation with landowners is essential to recovery of the species. (USFWS, 1985)

- Sustain healthy populations in their natural habitat at existing sites. In order to develop management plans for sustaining healthy populations, it may be necessary to learn more about the Texas poppy-mallow. (USFWS, 1985)
- Search potential habitat for additional populations. Other windblown sand deposits similar to the habitat presently occupied by Texas poppy—mallow exist on the upper Colorado River between Ballinger and Colorado City (a distance of about 80 miles). These areas need to be thoroughly searched for new populations. Additionally, deep sands are extensive in Jones, Haskell, Knox, Foard, Hardeman, and adjacent counties north of the presently known populations. Suitable habitat may exist in some of these counties and they should also be searched for presence of the species structure. (USFWS, 1985)
- Establish additional populations within the historic range. If searches fail to locate enough new populations to ensure safety for the species, expanding present populations within the essential habitat and introducing the species into new areas within its historic range would diminish the risk of extinction. (USFWS, 1985)
- Develop public awareness, appreciation, and support for presentation of the Texas poppy-mallow. Education and cooperation of the public is a vital part of the recovery process. Enlist the support of public interest groups such as the Texas Organization for Endangered Species, The Nature Conservancy, and local garden clubs. The visibility of this support can be instrumental in shaping public opinion. Useful tools in this endeavor would include talks and slide presentations to local interest groups and articles on the Texas poppy-mallow in newspapers and nature magazines. (USFWS, 1985)
- Recommendation for Future Action (USFWS, 2019a): Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria (U.S. Fish and Wildlife Service 2017). Use the MVP level and population delimitation distances described in this review as components of recovery criteria that address resilience and redundancy. Adopt the provisional recovery units discussed in this review to develop recovery criteria that address the species' ecological and genetic representation.
- Recommendation for Future Action (USFWS, 2019a): Promote awareness and conservation of Texas poppy-mallow in Runnels, Coke, Mitchell, and Scurry counties.
- Recommendation for Future Action (USFWS, 2019a): Seek permission to survey and monitor populations on private land.
- Recommendation for Future Action (USFWS, 2019a): Conduct up-to-date censuses of the accessible populations and revise the TXNDD EO records.
- Recommendation for Future Action (USFWS, 2019a): Work cooperatively with private landowners who are interested in conserving and managing the species on their lands. Consider voluntary measures to confer long-term protection for populations on private lands, such as conservation agreements and conservation easements.
- Recommendation for Future Action (USFWS, 2019a): Propagate the species, using seeds in the Lady Bird Johnson Wildflower Center seed bank, to establish seed production plots, renew the seed bank, and reintroduce populations in appropriate sites that can be protected.
- Recommendation for Future Action (USFWS, 2019a): Recommendation for Future Action (USFWS, 2019a): Obtain support for conservation actions from the Cooperative Endangered Species Conservation Fund (Section 6) or other grant sources.

- Not available.

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# SPECIES ACCOUNT: *Calystegia stebbinsii* (Stebbins' morning-glory)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/18/1996; Pacific Southwest (R8)

**Physical Description**

A leafy herbaceous perennial (persisting or living for several years with a period of growth each year) in the morning-glory family (Convolvulaceae). Its stems, which range up to 1 meter (3.3 feet) in length, generally lie flat on the ground. The leaves are palmately lobed (lobing radiating from a common point) with the two outermost lobes (major expansion or bulge) being divided again. The leaf lobes are narrow and lance-shaped. White flowers are on stalks 3 to 13 centimeters (1 to 5 inches) long and bear two leaf-like bracts. The fruit is a slender capsule. Calystegia stebbinsii flowers from May through June. Calystegia occidentalis (chaparral false bindweed) and C. purpurata ssp. saxicola (Pacific false bindweed) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). Calystegia stebbinsii can be distinguished from other California morning-glories by its distinctively shaped leaves, each having 7 to 9 narrow lance-shaped lobes. (USFWS, 2002)

**Taxonomy**

Brummitt (1974) described Calystegia stebbinsii (Stebbins’ morning-glory) from the type collection made by G. Ledyard Stebbins in 1970, 17 kilometers (10 miles) west of Placerville in El Dorado County, California. (USFWS, 2002)

**Historical Range**

In western El Dorado County that includes the Pine Hill formation (northern and southern portions). (USFWS, 2002)

**Current Range**

The species is found in El Dorado County within the immediate vicinity of the Pine Hill Preserve (though it is not found on Pine Hill itself) and sites near Grass Valley in Nevada County. Ongoing research indicates it may also occur in Shasta County, but this is not confirmed (USFWS, 2024).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

<u>Adult:</u> Lives for several years (USFWS, 2002).

**Breeding Season**

<u>Adult:</u> May through June (USFWS, 2002)

**Key Resources Needed for Breeding**

<u>Adult:</u> Insect pollinators; disturbance (USFWS, 2002)

**Reproduction Narrative**

Adult: The fruit is a slender capsule. Calystegia stebbinsii appears to emerge from a dormant seed bank or rootstock after disturbance. The plants grow and begin to flower in the year following germination or re-emergence. While an above-ground shoot may appear in the same spot for only several years, other portions of this plant’s extensive root system might survive much longer (L. Eng in litt. 1999). Pollination studies showed that animal vectors were needed for successful seed set. Observations showed that Calystegia stebbinsii is only pollinated by insects. Eighty percent of all visits were made by Hymenoptera, the Halictidae (solitary bees) and Apidae (honey bees) being the most important families (Nosal 1997). Seedproduction ranged from an average of 20.6 seeds per square meter (1.9 seeds per square foot) at Grass Valley to 380 seeds per square meter (35.3 seeds per square foot) at Salmon Falls. (USFWS, 2002)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Barrens, Shrubland/ chaparral (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Seeds require heat or scarification for germination. (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Well-burned areas; shade intolerant (USFWS, 2002)

**Spatial Arrangements of the Population**

Adult: Discontinuously scattered (USFWS, 2002)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from USFWS, 2002)

**Habitat Narrative**

Adult: Calystegia stebbinsii prefers mixed chaparral communities on gabbro-derived and serpentine-derived soils (NatureServe, 2015). Most occurrences of C. stebbinsii are discontinuously scattered within two population centers in the northern and southern portions of the Pine Hill formation. Calystegia stebbinsii produce fire adapted: seeds need heat or scarification for germination; plants grow well in burned-over areas, but are eliminated when surrounding chaparral grows tall enough to shade them. (NatureServe, 2015). Calystegia stebbinsii seems to be shade intolerant and does not occur beneath a closed canopy of vegetation (Baad and Hanna 1987). (USFWS, 2002)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019)

**Number of Populations:**

3 known extant; 8 presumed extant; 3 possibly extirpated; 1 extirpated. (USFWS, 2019)

**Population Size:**

Greater than 9800 individuals (USFWS, 2019)

**Additional Population-level Information:**

At the time of listing Stebbins' morning-glory, Pine Hill ceanothus, Pine Hill flannelbush, El Dorado bedstraw, and Layne's butterweed occurred primarily on the Pine Hill formation, an area of approximately 10,400 hectares (25,700 acres) in western El Dorado County, California, ranging in elevation from 138 to 628 meters (453 to 2,060 feet) (Service 1996, p. 54346). In addition, Stebbins' morning-glory and Layne's butterweed had "a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne counties" (Service 1996, p. 54346). Between the listing of the species and the 2019 review, additional occurrences were discovered or introduced outside of Pine Hill Preserve (Service 2019, p. 6). Most notably, a few occurrences of Stebbins' morning glory were identified in Nevada County near Grass Valley, two occurrences of Layne's butterweed were found in Yuba and Placer counties, and two additional occurrences of Layne's butterweed were identified in Tuolumne County (Service 2019, p. 6). The 2019 review also noted that occurrences of Pine Hill flannelbush (Diversity Database occurrences 8, 9, 13, 14, 15) had been recorded in Nevada and Yuba counties but that the species identification had not yet been verified (Service 2019, p. 6). Recent morphological studies suggest that the flannelbush plants in Nevada and Yuba counties are unique from Pine Hill flannelbush (USFWS, 2024)

**Population Narrative:**

At the time of listing Stebbins' morning-glory occurred primarily on the Pine Hill formation an area of approximately 10,400 hectares (ha) (25,700 acres (ac)), in western El Dorado County, California, ranging in elevation from 138 to 628 m (453 to 2,060 ft). In addition, Stebbins' morning-glory had "a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties" (Service 1996). Today, the species continue to occur primarily at the Pine Hill Preserve, but Stebbins' morning-glory has a few known occurrences in Nevada County near Grass Valley. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial

development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances. (USFWS, 2002)

**Stressor:** Other species-specific threats (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Calystegia stebbinsii is threatened by altered periodicity of fire (either too frequent or fire suppression), competition with invasive alien vegetation, herbicide spraying, and unauthorized dumping. There is an increased risk of extinction due to environmental, demographic, or genetic random events due to habitat fragmentation (USFWS, 2002).

**Stressor:** Alteration of the natural fire regime (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for Stebbins’ morning-glory  establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The State’s authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: the California Endangered Species Act, the Native Plant Protection Act, the California Environmental Quality Act, and the Natural Community Conservation Planning Act. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. Landowners are exempt from the prohibition for plants to be taken in the process of habitat modification. Protection of listed species through California Environmental Quality Act isdependent upon the discretion of the lead agency involved. The National Environmental Policy Act (NEPA) does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. More details about existing protections are provided in the 2019 5-Year Review. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. Secure and protect specified recovery areas from incompatible uses: (a) Cameron Park preserve north of Highway 50; (b) Cameron Park preserve south of Highway 50; (c) Salmon Falls/Martel Creek preserve; (d) occurrences in Nevada County; along with sufficient adjacent

unoccupied habitat for fire management and a 150-meter (500-foot) buffer. (USFWS, 2002)

2.Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective for all populations recommended for protection and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

3. Monitoring in all recommended preserves shows: (a) Populations stable or increasing over one fire cycle (about 30 years) (subject to modification depending on results of fire management studies). (b) Habitat monitoring shows a mosaic of multiage -class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserve over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats; (b) Fire management studies; (c) Research on genetics of Nevada County population; (d) Seeds of disjunct populations stored in at least two Center for Plant Conservation certified facilities; (e) Research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary (f) Maintain metapopulation dynamics of at least 2 very large, 7 medium, and 4 small occurrences throughout the northern and southern portions of the Pine Hill formation; and of at least 1 medium and 5 small occurrences near Grass Valley in Nevada County. (USFWS, 2002)

Recovery Priority Number: 5C

**Delisting Criteria:**
1. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all occurrences and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

2. Monitoring in all recommended preserves shows: (d) No population decline after downlisting during two additional fire cycles (about 60 years); if declining, determine cause and reverse trend. (e) Habitat monitoring continues to show a mosaic of multi-age class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions. (f) Spatially and temporally, the establishment of occurrences must continue to be greater than the extirpation of occurrences. (USFWS, 2002)

3. Other actions: (g) Ameliorate or eliminate threats. (USFWS, 2002)

**Recovery Actions:**
- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for

two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)

- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Nevada County on gabbro and serpentine soils. Reproduction and Demography Research: Including determining limiting life stages, seed production, and survival in soil to determine appropriate fire return period. Genetics research. Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; seed banking for disjunct populations. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans.

(USFWS, 2002)

- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Preserves must include sufficient habitat to allow for expansion or shifts in occupied habitat.
- In addition to securing and protecting habitat, maintenance of the metapopulation dynamics will be important for survival and recovery.
- Unless the metapopulation analysis shows otherwise, at least two very large occurrences each greater than 128 hectares (315 acres); seven medium occurrences each between 4 and 40 hectares (10 and 100 acres); and four small occurrences each smaller than 4 hectares (10 acres), are to be maintained at any given time throughout the northern and southern portions of the Pine Hill formation. In addition at least one medium and five small occurrences are to be maintained at any given time at the metapopulation near Grass Valley in Nevada County.
- In addition to securing and protecting habitat, directed surveys for Calystegia stebbinsii should be conducted on gabbro and serpentine soils in Nevada County. If plants (or additional populations) are discovered in Nevada County, they should be secured through land acquisition, conservation easements, or other means. (USFWS, 2002)
- In addition, unoccupied habitat that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected along with sufficient adjacent unoccupied habitat for fire management, and a 150-meter (500-foot) buffer for fire safety. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- Stebbins' morning-glory 1. Verify the identity of the possible occurrence at Whiskeytown National Recreation Area. (USFWS, 2024)

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# SPECIES ACCOUNT: *Campanula robinsiae* (Brooksville bellflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/28/1989; Southeast Region (R4)

**Physical Description**

Campanula robinsiae is an annual herb, with stems 1-15 cm2 (0.5-6 in.) tall, very slender, simple or branched, faintly winged or 4-angled. The stems are glabrous except for a few trichomes in the angles (Morn 1987). The plant may be submerged for part of its life, which may affect its growth. Some stems root at the nodes (Morn 1987). The leaves are alternate, the blades varying in size and shape on different parts of the plant and from plant to plant (Morn 1987). Open flowers are solitary, 3-10 mm long, bell-shaped, “deep purple” (Morn 1987). Steven Leonard (under contract to The Nature Conservancy; report at Florida Natural Areas Inventory) discovered in 1983 that the plant has cleistogamous (closed, self-pollinating) flowers, which are quite small. This is the only North American Campanula with cleistogamous flowers (Morn 1987). The fruit is a subglobose capsule about 2 mm in diameter (Wunderlin et al. 1 980a). The seeds are about 1 mm long, the smallest of any North American member of the genus (Shetler and Morn 1986; description adapted from Wunderlin et al. [1980a] and other sources as noted). Leonard observed only cleistogamous flowers on February 8 and 11, 1983, and did not see a chasmogamous flower until February 23 (letters from Leonard to Morn in Morn 1987). Flowering specimens have also been collected March 11, 1983; April 13, 1983; and April 26, 1958. Seed production proceeds while flowering continues. Campanula robinsiae may be confused with Campanula floridana, but the latter species has very different seeds and leaves that are “much firmer than those of C. robinsiae” (Morn 1987). (USFWS, 1993)

**Taxonomy**

Small (1926) formally published the species, but later (Small 1933) transferred the species to his new genus Rotantha, along with Campanula floridana, based on the shared character of their rotate corollas’ (Small 1933). Later workers (Shetler 1963, Wunderlin et al. 1 980a) determined that these two species are not closely related, so Rotantha is an artificial genus; the two species are retained in Campanula (USFWS, 1993).

**Historical Range**

All historically known sites of C. robinsiae occurred within approximately 2-3 square miles centered on Chinsegut Hill, which is located 5 miles north of Brooksville, in Hernando County, Florida. (USFWS, 2019)

**Current Range**

Hernando and Hillsborough Counties, Florida. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from EPA, 2016); asexual (EPA, 2019)

**Breeding Season**

Adult: March - April (EPA, 2016)

**Key Resources Needed for Breeding**

Adult: rainfall (USFWS, 2010)

**Reproduction Narrative**

Adult: Flowering specimens have been collected March-April. Capable of self-pollination.Seeds germinate in winter or spring. Seed production occurs while flowering continues (USFWS, 2019). It was determined that water levels from rainfall rather than time of year may be a critical factor controlling germination (Williams 1998) (USFWS, 2010).

**Habitat Type**

Adult: Palustrine, terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Herbaceous wetland, forest (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Campanula robinsiae was originally found in a seepage area on the north facing slope of Chinsegut Hill surrounded by pasture used for animal husbandry. It has since been found within an oak/palm hydric hammock along the edge of an elongated maidencane (Panicum hemitomom) marsh at Burns Prairie (Laundry 1996). Typically this species is found along the margins of ponds and marshes with fluctuating water levels and moist seepage areas, both surrounded by pastures. C. robinsiae is associated with other wetland plants, such as mosquito fern (Azolla carolinaiana), hair sedge (Bulbostylis spp.), coinwort (Centella asiatica), button snakeroot (Eryngium spp.), pennywort (Hydrocotyle spp.), rush (Juncus spp.), pimpernel (Anagallis minima), pearlwort (Sagina decumbens), and maidencane (Panicum hemitomom). (USFWS, 2019)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Stable (USFWS, 2019)

**Number of Populations:**

7 (USFWS, 2024)

**Population Size:**

~5,000 individuals (USFWS, 2024)

**Population Narrative:**

Seven populations. All extant populations occur on publicly-owned lands, not necessarily conservation lands. The Brooksville Sec 24 (EO 1) and Chinsegut Hill (EO 3) populations occurred on private lands. The former population no longer has suitable habitat present and the latter population’s marginal habitat has degraded to what appears unsuitable. Surveys performed at this location have not detected species presence for many decades (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is threatened by habitat destruction and degradation on its six extant sites due to the lack of habitat management and development of the land surrounding protected sites. Previously, conversion of existing sites to residential and agriculture was determined to be the primary threat and resulted in the need to list the species (USFWS 1994). Since all six known extant populations now occur on public land, the threat of conversion of known sites to residential land use has been significantly reduced. The lack of habitat management has resulted in the disappearance of the Chinsegut Hill and Young populations and may be affecting other populations, such as the introduction and Burns Prairie. At Chinsegut Hill and the Young site, C. robinsiae was likely outcompeted by dense vegetation due to lack of disturbance, which was previously created by mowing or trampling by cattle. In addition, at Chinsegut Hill, the death of an oak tree that provided shade to C. robinsiae likely affected moisture levels (Service 2010). It is important to consider overstory composition when managing habitat. The introduction at the Blackwater Creek Preserve failed due to lack of habitat management that would have allowed cattle to graze the site. In 2012, Burns Prairie lost its grazing cattle and the only management that has taken place is that overgrown competing vegetation was removed in 2015 (Peterson, BTG pers. comm. 2019a). It is possible that this population will disappear if grazing or other habitat management is not continued. More research is needed to determine which methods are effective at managing habitat. Development of the land surrounding protected lands may alter hydrology by increasing runoff to C. robinsiae sites. This runoff may also contain fertilizers and herbicides that may affect growth and germination of the plants. C. robinsiae occurs in the Central Region of Florida, which is projected to experience the greatest population growth in the state in the near future. By 2070, the percentage of developed land is expected to double from 25% in 2010 to almost 50% (Carr and Zwick 2016). Due to modeling efforts (Lewis 2010, 2011), unknown populations and suitable habitat for introductions likely exist on private land and may be at risk to development. It is likely that agricultural lands will be converted to residential land uses in the near future (Carr and Zwick 2016). This conversion may negatively affect C. robinsiae habitat because cattle may benefit the species by providing the disturbance necessary to reduce competition from other plants. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
Not developed

Recovery Priority Number: 8

**Delisting Criteria:**
Not developed - Plausible criteria for recovery might include securing at least 10 viable and self-sustaining populations of Brooksville bellflower in pond margin habitats, consisting of approximately 10,000 individuals during prolific years (USFWS, 1993).

**Recovery Actions:**

- Develop management and protection criteria for populations on current managed areas (includes collection of biological/systematic data and control of exotic plants) (USFWS, 1993).
- Acquire additional habitat, or protect habitat through conservation easements and/or regulation. Sufficient information is available to proceed immediately (USFWS, 1993).
- Conduct additional surveys for new populations of the species (USFWS, 1993).
- Augment existing cultivated populations, including establishment of a germ plasm bank (USFWS, 1993).
- Develop plans for possible (re)introduction of plants into suitable habitats (includes 10-year monitoring of existing and/or reintroduced populations) (USFWS, 1993).
- Enforce protective legislation (USFWS, 1993).
- Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2010).
- Support further research on: a. Effects of cattle grazing on this species. b. Life history needs. c. Microhabitat requirements of this species. d. Effect of severe changes in temperatures (freezing) on germination. e. Drought and fluctuating water levels and their effect on germination. f. Transplant experiments, long-term seed viability trials, and optimizing germination protocols (USFWS, 2010).
- Continue working with public land managers to increase management efforts to benefit C. robinsiae. No management plans have been developed for this species but are necessary. Minimal management has been taking place at some sites. Once disturbance has been removed from some sites, populations have disappeared. Burns Prairie especially needs additional management because competing vegetation has taken over since grazing cattle were removed from the site. (USFWS, 2019)
- Continue conducting surveys at known sites of occurrence and expand surveys to other suitable areas in Hillsborough and Hernando Counties. This information is necessary to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites. BTG has continued conducting surveys at known sites of occurrence. This work has been made possible through annual grants from the State of Florida, Department of Agriculture and Consumer Services, Division of Plant Industry, which funds the basic operations of BTG’s Rare Plant Conservation Program. Surveys have been expanded to other sites determined by a GIS model to have suitable habitat. However, due to either flood or drought conditions during the survey periods, no plants were found. One introduction took place in 2013, but no plants were found the following year due to

overgrowth of competing vegetation. No plants have been found at the introduction site since. Habitat management is necessary to control competing vegetation. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES The same future recommendation from previous 5-year reviews remain valid. The following recommendations are a brief summary from those prior reports. A. Support research on: • Effects of cattle grazing, • Life history needs, • Microhabitat requirements, • Temperature effects on germination, • Drought and fluctuating water levels on germination. B. Transplant experiments, long-term seed viability trails, and optimizing germination protocols. C. Collaborating with land managers to increase beneficial habitat management. D. Continue conducting surveys at known locations and expand surveys to included potential suitable areas (USFWS, 2024).

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# SPECIES ACCOUNT: *Cardamine micranthera* (Small-anthered bittercress)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/23/1989; Southeast Region (R4)

**Physical Description**

It is an erect slender perennial herb with fibrous roots and one (or rarely more) simple or branched stem(s) growing 2 to 4 decimeters tall. Basal leaves are 1 to 5 centimeters long (occasionally longer), 0.5 to 2.0 centimeters wide, crenate, with one (or rarely two) pairs of small lateral lobes or leaflets. The stem leaves are alternate and mostly unlobed, 1 to 1.5 centimeters long, crenate and cuneate. Flowering and fruiting occur in April and May. The flowers, subtended by leafy bracts, have four white petals, six stamens, and small, round anthers. The fruit is a silique, 0.8 to 1.2 centimeters long and approximately 1 millimeter in diameter, with a beak 1 to 1.2 millimeters long. The brown seeds are approximately I millimeter long. Cardamine micranthera can be distinguished from its most similar relative, Cardamine rotundifolia, by its much smaller, nearly orbicular (instead of oblong) anthers, smaller flowers, and more angulate and nonclasping leaves. In Cardamine micranthera, the anthers are about 0.5 millimeter long, and the petals are 1.2 to 2 millimeters wide. Stem leaves of Cardamine micranthera are typically broadly cuneate (rarely narrowly cuneate, oblique, or cordate) and never cordate-clasping. Cardamine micranthera is typically erect, or occasionally has decumbent stems, but these do not develop proliferating branches. C. micranthera has only one to two pairs of lateral leaflets (or none), with the terminal leaflet being nearly one-half the total length. Cardamine micranthera has pedicels 9 to 15 mm long and siliques 14 to 22 mm (pods only one and one-fourth to one and one-half times the length of the stalks). The beak of the fruit corresponds to the style in the flower and is that portion of the pod extending beyond the seed-bearing part. Cardamine micranthera's beak is about 2 mm long and can be readily seen as a sharp, spindle-like tip on the pod (T. Wieboldt, personal communication, 1991). (USFWS, 1991)

**Taxonomy**

Cardamine micranthera was first described by R. C. Rollins (1940) from material collected in North Carolina in 1939. (USFWS, 1991)

**Historical Range**

Native to the Dan River drainage of the North Carolina and Virginia piedmont. Historically found in Stokes and Forsyth Counties (USFWS, 1991).

**Current Range**

Stokes County, North Carolina and Patrick County, Virginia. (USFWS, 2016)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Ants have been observed visiting the flowers (USFWS, 1991).

**Habitat Type**

Adult: Palustrine, terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Riparian, forest (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full to partial shade (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Seepages, wet rock crevices, streambanks, sandbars, and wet woods along small streams (Murdock and Weakley 1991). The environmental specificity of this specie is narrow; C. micranthera occupies moist soils of the upper Piedmont that are fully to partially shaded (Murdock and Weakley 1991). More specifically, it is typically found in wet, boggy soils of deciduous woodlands and moist to wet soils along the edge of small to intermediate sized streams (NCA 1996). Within the stream bed plants also inhabit sand and gravel bars and wet rock crevices (Murdock and Weakley 1991) (NatureServe, 2015).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Species Trends:**

Declining (NatureServe, 2015)

**Number of Populations:**

29 (13 North Carolina. 16 Virginia) (USFWS, 2023).

**Population Size:**

Annual fluctuation; < 23,000 (USFWS, 2016)

**Population Narrative:**

Cardamine micranthera was federally listed in 1989, the listing rule described four populations all confined to the Dan River basin in North Carolina. In 1991 a recovery plan was developed for the species and by then five additional populations had been discovered in Patrick County, Virginia totaling nine extant populations (four in North Carolina and five in Virginia) (Service 1991). At the time of the 2016 5-year review, the number of known extant populations had increased from 9 to 32 (Service, 2016). New populations remained in the narrow range of the

Dan River system of Stokes County, North Carolina and Patrick County, Virginia. Estimates of abundance for the 32 extant populations of the species ranged from one plant (North Fork of South Mayo River, VA) to 8,000 – 10,000 plants (Peters Creek, VA) (Appendix A). Since the 2016 5-year review, three populations (Service populations 1, 25, and 32, Appendix A have been moved from a D-ranking (poor viability) to F (failed to find). Therefore, the current species range remains confined to 29 populations in the Dan River system in Stokes County, NC and Patrick County, VA. The 29 extant populations (13 in NC and 16 in VA) represented by current (within the last 5 years) population surveys ranged from 10 to 3,000 plants. New occurrences were identified in Patrick County, VA (Van Alstine 2018). One hundred and fifty-two new plants were found within Peters Creek and Little Peters Creek and one new plant in Russell Creek (Van Alstine, N.E. 2018). One new discrete site has been added to the Dan River, NC (NCNHP 2021). The EOs have been expanded to represent these increases. These 29 populations represent some 124 sites (28 in NC and 96 in VA). A historical review of extant populations and more current information is provided below (Tables 1 and 2). The number of populations in North Carolina has remained stable at 13 since 2016. Of these 13 populations, five were surveyed in 2013 and eight were surveyed in 2018 (NCNHP 2021). The number of extant populations in Virginia has declined from 20 to 16 (Van Alstine 2016, 2018). Of these 16 populations, 2 were surveyed in 2004, 6 in 2014, 4 in 2015, 2 in 2017 and 2 in 2020. Current estimates of abundance for the 29 populations range from ten plants (Dan River, NC) to 3,000 – 5,000 plants (Peters Creek, VA) (Appendix A). Nine of the 29 populations are in a decline, 4 are stable, 8 are increasing, and 8 are unknown. Survey data which post-dates the 2016 5-year review has been provided by the VADCR which completed population counts of C. micranthera in the area surrounding Patrick County, VA. This effort was accomplished with funds provided under Section 6 of the Act, and data includes both extant and extirpated populations. This monitoring revealed population sizes from 11 known sites. Six of the 11 populations declined, ranging from 19.29% to 100% population loss, two sites had a population increase of 68% and 90%, and three populations are extirpated. In North Carolina, nine surveys post-date the previous 2016 5-year review and include both extant and failed to find populations. Four populations declined, ranging from 28.26% to 90.38% population loss; one remains stable; and three have increased by an average of 217 plants and one population is considered a 'failed to find.' A summary of the current survey data is provided in Appendix A. Recent survey efforts find that the number of documented C. micranthera populations has decreased since the last 5-year review in 2016. Inconsistent and infrequent monitoring increases uncertainties associated with the species' status and trends and the status of individual populations cannot be adequately assessed at this time (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Beaver dams (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Beaver dams have been observed to constitute a significant threat to Cardamine micranthera at some locations, with one knowledgeable observer regarding this as perhaps the most immediate threat to the species (Bridle 2009, pers. comm.). Bridle notes that beaver activity (especially in drought years) within main stream channels has flooded entire colonies of the species (USFWS, 2016).

**Stressor:** Habitat destruction and modification (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat alteration remains the primary threat to Cardamine micrantera, with impoundment, channelization, conversion associated with agriculture or silviculture, flooding, and encroachment of exotic species as threats affecting the species. Cattle trampling and downstream beaver impoundments have also been noted as threatening C. micranthera habitat (USFWS, 2016).

**Stressor:** Inadequacy of regulatory mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** State statutes primarily regulate collection and trade in listed species, and do not prohibit land owners from neglecting or otherwise impacting such species on their own properties or in conjunction with otherwise legal activities (USFWS, 2016).

**Stressor:** Timber Harvest/Invasive species (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Disturbances to the floodplain, tributaries, and river basins due to timber harvesting further support erosion and sedimentation loss while also removing the canopy over stream banks where C. micranthera is often located. Additionally, these disturbances present a risk of common invasive species which were found in the Gilbert Mills, Peters Creek North, and Peters Creek Central Sites of Virginia. Microstegium vimineum (Japanese stiltgrass) was commonly found on the silt/sand bars, Lonicera japonica (Japanese honeysuckle) and Rosa multiflora (multiflora rose) were occasionally present on streambanks and Murdannia keisak (marsh dewflower) was also noted (VanAlstine, 2018). Three site records, Gilbert Mills, Peters Creek North, and Peters Creek Central Sites of Virginia, specifically note that one or more of these threats are either ongoing or imminent, further noting the need for active intervention to address them (USFWS, 2023)

***Recovery***

**Reclassification Criteria:**
Not defined (USFWS, 1991)

Recovery Priority Number: 5

**Delisting Criteria:**
1. It has been documented that at least six populations are self-sustaining and that necessary mangement actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 1991).

2. All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations

(USFWS, 1991).

**Recovery Actions:**

- Protect existing populations and essential habitat. Only nine populations of small-anthered bittercress are currently known to exist, all in the piedmont of North Carolina and Virginia. Until more is known about the species' biology and specific habitat requirements, and about the measures necessary to protect occupied sites, all existing populations should be protected. The long-term survival of six populations is believed to be essential to the recovery of the species as a whole. (USFWS, 1991)
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Protection of the species' habitat is the obvious first step in ensuring its long-term survival, but this alone may not be sufficient. Since very little is known about this species, information on its population biology and ecology is necessary before effective management guidelines can be formulated and implemented.
- Develop a cultivated source of plants and provide for long-term seed storage. There are presently no cultivated sources of this species. Techniques for seed storage, germination, and maintenance of cultivated specimens must be developed. (USFWS, 1991)
- Enforce laws protecting the species and/or its habitat. The Endangered Species Act prohibits taking of Cardamine micranthera from Federal lands without a permit and regulates trade. Section 7 of the Act provides additional protection of the habitat from impacts related to federally funded or authorized projects. In addition, the 1988 amendments to the Act prohibit (1) the malicious damage or destruction of listed plants on Federal lands and (2) the removal, cutting, digging, damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. The State of North Carolina prohibits taking of the species without a permit and the landowner's written permission and regulates trade in the species (North Carolina General Statute 19-B, 202.12-202.19). The State of Virginia prohibits taking and trade of listed species without a permit (Code of Virginia 39:3.1-1020 to 31-030). Federal and State enforcement agents whose jurisdiction includes the known range of small-anthered bittercress should be made aware of the threats to the species and be able to identify specimens. (USFWS, 1991)
- Develop materials to inform the public about the statu of the species and the recovery plan objectives. Public support for the conservation of small-anthered bittercress could play an important part in encouraging landowner assistance and conservation efforts. Information materials should not identify the plant's locations so as not to increase the threat of taking or vandalism. Annually assess success of recovery efforts for the species. Review of new information, evaluation of ongoing actions, and redirection, if necessary, is essential for assuring that full recovery is achieved as quickly and efficiently as possible. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Continue to pursue follow-up information from stream restoration project on Snow Creek (involving a portion of one population of this species) from appropriate state, federal and private parties. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Communicate existing habitat protection priorities (VDCR 2007, Boyer 1996) to state agencies, local land trusts, and other conservation partners, to assess current and future options for protection. Encourage land protection strategies focused on headwater occurrences likely to serve as a seed source for recolonization of sites further downstream (Bridle 2009, pers. comm.). (USFWS, 1991)

- Recommendation for Future Action from 2016 5-Year Review: Identify sites which have experienced recent disturbance, and evaluate the effects of ongoing and prior habitat disturbance upon the species. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Utilize information obtained from assessments of prior or ongoing habitat disturbance to devise and implement appropriate habitat management guidelines. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 5. Conduct site visits to determine if Boyer's (1996) long-term monitoring transects can be relocated and resurrected. If so, reinitiate monitoring efforts to learn more about the longevity and relative stability of populations of this short-lived species. If Boyer's (1996) monitoring transects cannot be resurrected, work to establish comparable monitoring (using Boyer's protocol or modifications thereof) at priority sites using standardized monitoring methods. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 6. Use monitoring data and other information to draft objective, measurable criteria for "selfsustaining" populations . (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 7. Determine the status of genetic material held in botanical gardens and other institutions, and work to ensure that the species is adequately represented in long-term storage. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 8. Pursue development of habitat predictability models for this species, and iteratively refine and use these to search for new populations and guide land protection efforts. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 9. Identify landowners, obtain permission to visit populations, and provide information to landowners about voluntary protection measures that may be implemented to protect the species (including best management practices, NHP Registry programs, conservation easements, and fee simple purchase by cooperating land protection agencies). (USFWS, 1991)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The following activities are recommendations to improve recovery of the species. 1. Continue to pursue follow-up information from stream restoration projects on Snow Creek (involving a portion of one population of this species) from appropriate state, federal and private parties. (Recovery Task 4). 2. Communicate existing habitat protection priorities (VDCR 2007, Boyer 1996) to state agencies, local land trusts, and other conservation partners, to assess current and future options for protection. Encourage land protection strategies focused on headwater occurrences likely to serve as a seed source for recolonization of sites further downstream (Bridle 2009, pers. comm.) (Recovery Task 1.4). 3. Identify sites which have experienced recent disturbance and evaluate the effects of ongoing and prior habitat disturbance upon the species (Recovery Task 2.4). 4. Utilize information obtained from assessments of prior or ongoing habitat disturbance to devise and implement appropriate habitat management guidelines (Recovery Tasks 2.5 and 2.6). 5. Conduct site visits to determine if Boyer’s (1996) long-term monitoring transects can be relocated and resurrected. If so, reinitiate monitoring efforts to learn more about the longevity and relative stability of populations of this short-lived species. If Boyer’s (1996) monitoring transects cannot be resurrected, work to establish comparable monitoring (using Boyer’s protocol or modifications thereof) at priority sites using standardized monitoring methods (Recovery Tasks 2.1, 2.2, and 2.3). 6. Use monitoring data and other information to draft objective, measurable criteria for “self-sustaining” populations (Recovery Tasks

2.3, 2.4, and 2.5). 7. Determine the status of genetic material held in botanical gardens and other institutions, and work to ensure that the species is adequately represented in longterm storage (Recovery Task 3). 8. Pursue development of habitat predictability models for this species, and iteratively refine and use these to search for new populations and guide land protection efforts (Recovery Tasks 1.2 and 1.3). 9. Identify landowners, obtain permission to visit populations, and provide information to landowners about voluntary protection measures that may be implemented to protect the species (including best management practices, NHP Registry programs, conservation easements, and fee simple purchase by cooperating land protection agencies) (Recovery Tasks 1.1, 1,2, 1.3, and 1.4) (USFWS< 2023)

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# SPECIES ACCOUNT: *Castilleja affinis ssp. neglecta* (Tiburon paintbrush)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 3/6/1995; Pacific Southwest (R8)

**Physical Description**

Castilleja affinis ssp. neglecta (Figure II- 5) is a semi-woody perennial of the snapdragon family (Scrophulariaceae), with erect, branched stems 30 to 60 centimeters (1 to 2 feet) tall and a sparse covering of soft, spreading hairs (Munz and Keck 1959). The lance-shaped leaves are 20 to 40 millimeters (0.8 to 1.6 inches) long and have 0 to 5 lobes (Hickman 1993). The conspicuous floral bracts are yellowish and sometimes red-tipped; the flowers are yellow to red and 18 to 20 millimeters (0.7 to 0.8 inch) long. (USFWS, 1998)

**Taxonomy**

Transferred to varietal rank by Egger (2008). Treated as Castilleja affinis ssp. neglecta by Kartesz (1999 Synthesis), by The Jepson Manual (Hickman, 1993) and by the U.S. Fish and Wildlife Service. Originally named as a species (Castilleja neglecta), and treated at that level by Kartesz (1994). Kartesz notes (pers. comm. to Larry Morse, 25Nov99) that his treatment of this as a subspecies is based on a 1992 personal communication with Chuang. (NatureServe, 2015)

**Historical Range**

Never widespread;  in 1998, locations were on the Tiburon Peninsula in Main County, one population in Napa County, and one population in Santa Clara County (USFWS, 1998)

**Current Range**

Known from Marin, Napa, Santa Clara counties in California (USFWS, 2012)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2012)

**Dependency on Other Individuals or Species**

Adult: The yellow flowers of Castilleja affinis ssp. neglecta are pollinated by hummingbirds (County of Santa Clara et al. 2010). (USFWS, 2012)

**Breeding Season**

Adult: April to June (USFWS, 1998)

**Key Resources Needed for Breeding**

Adult: Low temperatures and leaching (USFWS, 1998)

**Reproduction Narrative**

Adult: Castilleja affinis ssp. neglecta is a root parasite on other angiosperm (flowering plant) species. Castilleja affinis ssp. neglecta is a perennial, flowering from April to June (Munz and Keck 1959). The yellow flowers of Castilleja affinis ssp. neglecta are pollinated by hummingbirds (County of Santa Clara et al. 2010). Seed germination occurs in January or February and seems to be induced by leaching and low temperatures (5 to 15 degrees Celsius or 45 to 59 degrees Fahrenheit) (Martin 1989). The mean number of inflorescences per plant was 2.3, the mean number of capsules per inflorescence was 8.8, and the mean number of seeds per capsule was 82.3. Based on these figures, seed production for 1 year was calculated to be 1,666 seeds per plant (Martin 1989). The plant dies back to its woody base after seed dispersal and new growth occurs after the first winter rain. Heckard (1968) observed evidence that polyploidy leads to patterns of variation that can lead to hybridization while plants maintain differences in their appearance. (USFWS, 1998; USFWS, 2012)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Serpentine grasslands (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Leaching and low temperatures (USFWS, 1998)

**Geographic or Habitat Restraints or Barriers**

Adult: Grows at elevations between 75 and 400 meters (USFWS, 2012)

**Spatial Arrangements of the Population**

Adult: Scattered colonies (USFWS, 2012)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2012)

**Site Fidelity**

Adult: High (inferred from USFWS, 2012)

**Dependency on Other Individuals or Species for Habitat**

Adult: The primary advantage of the parasitic attachment in Castilleja and related plants in the figwort family is reportedly an increased water and mineral supply. Though the parasitic relationship is not obligate (hemiparasitic), benefits to species of Castilleja from the parasitic habit are manifested in increased vigor with more branching, greater height, and earlier flowering (Heckard 1962). Heckard (1962) showed that a host plant is beneficial to Castilleja affinis spp. neglecta and increases the species' chance for survival. (USFWS, 1998)

**Habitat Narrative**

Adult: Three scattered colonies of the occurrences of Castilleja affinis ssp. neglecta in Marin County occur on the Tiburon peninsula. Castilleja affinis ssp. neglecta occurs in serpentine bunchgrass communities typically on north to west facing slopes. Castilleja affinis ssp. neglecta grows on open, rocky, serpentine slopes within the serpentine grassland communities, between about 75 and 400 meters in elevation in Napa, Marin, and Santa Clara Counties (Service 1998, Safford et al. 2005, LSA 2007, CDFG 2010). Seed germination occurs in January or February and seems to be induced by leaching and low temperatures (5 to 15 degrees Celsius or 45 to 59 degrees Fahrenheit) (Martin 1989). Castilleja affinis ssp. neglecta parasitic attachment increases water and mineral supply. Though the parasitic relationship is not obligate (hemiparasitic), benefits to species of Castilleja from the parasitic habit are manifested in increased vigor with more branching, greater height, and earlier flowering (Heckard 1962). Heckard (1962) showed that a host plant is beneficial to Castilleja affinis spp. neglecta and increases the species' chance for survival. (USFWS, 1998; USFWS, 2012)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal occurs from June to October. (USFWS, 2012)

**Additional Life History Information**

Adult: Seed dispersal occurs from June to October. (USFWS, 2012)

***Population Information and Trends***

**Number of Populations:**

8 (USFWS, 2012)

**Population Size:**

Approximately 2,000 plants (USFWS, 2012)

**Population Narrative:**

The distribution of C. affinis ssp. neglecta has never been widespread. Seven occurrences are described: five in Marin County (three of which occur on the Tiburon Peninsula), one near American Canyon in Napa County, and one in Santa Clara County (Service 1998, CDFG 2010). The CNDDB reports one additional occurrence in Santa Clara County (CDFG 2010) and one occurrence from Stinson Beach in Marin County that was last observed at 1965 with the exact location and number of plants listed as unknown (CDFG 2010). The range of C. affinis ssp. neglecta is approximately 50 kilometers (30 miles) from east to west, and 112 kilometers (70 miles) from north to south (Service 1995). (USFWS, 2012)

***Threats and Stressors***

**Stressor:** Residential Development (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** When Castilleja affinis ssp. neglecta was listed as endangered in 1995, residential development was identified as a primary threat to Marin County populations. It remains a significant threat today. At the time of listing, the St. Hilary's church occurrence on the Tiburon peninsula was threatened by a proposed residential development. A portion of the land supporting this population was purchased by the Marin County Open Space District and Town of Tiburon in 1997 as an open space preserve (the Old St. Hilary's Open Space Preserve), however, a

portion of the population remains on private land where residential development has been proposed on multiple occasions. Residential development on the Middle Ridge adjacent to Tiburon paintbrush habitat is anticipated to occur in the near future (S. Anderson personal communication 2009). (USFWS, 2012)

**Stressor:** Mining/Landfill (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Both Santa Clara County occurrences of Castilleja affinis ssp. neglecta occur on private land associated with the Kirby Canyon Landfill. However, both are located in areas currently managed as mitigation sites for landfill impacts. Both occurrences are monitored and managed by the Kirby Canyon Butterfly Trust, but neither site is permanently protected (County of Santa Clara et al. 2010). At the time of listing, the Napa County occurrence was threatened by the potential expansion of the American Canyon Quarry. In 1999 private landowners donated land supporting 5 to 10 percent of the Castilleja affinis ssp. neglecta occurrence to the City of American Canyon in order to create the Newell Preserve; the Land Trust of Napa County holds a conservation easement on the preserve land (Napa County Land Trust website). Currently, there are no active plans for quarry expansion on the land that supports the majority of this occurrence and quarry reclamation which was initiated in 2007 is not anticipated to affect this occurrence (D. Barrella personal communication 2011). However, the quarry property is in an area zoned for agriculture and low density residential and could potentially be developed in the future. (USFWS, 2012)

**Stressor:** Recreation (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time Castilleja affinis ssp. neglecta was listed, we cited pedestrian traffic associated with recreation activities as a Factor A threat for the Middle Ridge and Ring Mountain populations of C. affinis ssp. neglecta on the Tiburon peninsula. Currently, wayward trails continue to crisscross Ring Mountain Preserve resulting in a small reduction in available habitat. C. affinis ssp. neglecta is most likely to be negatively affected by hikers, cyclists, and equestrians if they stray from designated and social trails and trample plants or if new trails are established. C. affinis ssp. neglecta plants on the Middle Ridge of the Town of Tiburon faces threats from hikers and their dogs that trample plants and habitat despite posted signs warning sensitive plant habitat (E. Buxton personal communication 2009). (USFWS, 2012) Currently, visitors are only allowed to visit Newell Preserve in Napa County during docent-led tours. Therefore, trampling and habitat destruction from recreational hikers, dogs, cyclists, and equestrians is currently not a threat to this Castilleja affinis ssp. neglecta occurrence. However, a master plan is being developed for the preserve that will likely include allowing public access without docent supervision. (USFWS, 2012)

**Stressor:** Landslide/Erosion (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** At the time of listing, soil slumping was identified as a threat to the Castilleja affinis ssp. neglecta occurrence at Ring Mountain Preserve (Service 1995). The toe of the slope that supports the population was removed to accommodate residential development in Corte Madera in the 1960s and soil from the slope slips onto the street below. Some Town of Tiburon Open space parcels are mapped as being prone to landslides and erosion occurs along some trails and watercourses on open space parcels, but neither appears to be a major threat to C. affinis ssp. neglecta at this time (LSA 2010). (USFWS, 2012)

**Stressor:** Grazing (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cattle grazing was cited as a factor C threat to Castilleja affinis ssp. neglecta at the time of listing. Improper grazing may remain a potential threat to the species, however, grazing can also be used as a management tool to reduce biomass of non-native vegetation and may actually be beneficial to the species if managed appropriately (County of Santa Clara et al. 2010). (USFWS, 2012)

**Stressor:** Herbivory (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mammal herbivory by mule deer (Odocoileus hemionus) and black-tailed jackrabbits (Lepus californicus) may pose a threat to Castilleja affinis ssp. neglecta on the Ring Mountain Preserve. Results from 2007 monitoring showed that approximately 25 percent of the inflorescence branches in the 53 plants evaluated were removed by herbivory (LSA 2007). However, side branches developed when tips of branches were removed, so this type of herbivory may not pose a substantial threat. Disturbance from feral pig (Sus scrofa) rooting poses a threat to the Paintbrush Hill occurrence in Santa Clara County (County of Santa Clara et al. 2010). Cameras placed at the Santa Clara occurrences have documented rabbits and deer in the area and sharp incisions on the plants suggest that rabbits may be eating some C. affinis ssp. neglecta flowers and fruit at this location (C. Niederer personal communication 2011). It is not known whether any diseases threaten the species. (USFWS, 2012)

**Stressor:** Non-native Invasive Plant Species (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from non-native invasive plant species continues to pose a serious threat to Castilleja affinis ssp. neglecta on the Tiburon peninsula. At the Ring Mountain Preserve, the Marin County Open Space District has been working to eradicate or control non-native invasive species for several years. The Ring Mountain Preserve Sensitive Resource Monitoring Plan (LSA Associates, Inc. 2007) provides a list of non-native invasive species that currently occur on Ring Mountain and describes treatment recommendations. Similarly, the Town of Tiburon has an Open Space Resource Management Plan (LSA 2010) that addresses invasive species that affect the Middle Ridge occurrence of C. affinis ssp. neglecta. Bull thistle (Cirsium vulgare), French broom (Genista monspessulana), and wild oats (Avena spp.), are problematic on parcels supporting C. affinis ssp. neglecta. Weed abatement is an ongoing activity that will likely need to

occur in perpetuity at these locations. (USFWS, 2012) Non-native invasive plant species occur to some extent in association with occurrences of Castilleja affinis ssp. neglecta outside the Tiburon peninsula as well. Point Reyes National Seashore is working to control an invasion of distaff thistle (Carthamus lanatus) in the vicinity of the Nicasio Ridge occurrence of C. affinis ssp. neglecta within the GGNRA and hand removal of tocolote (Centaurea melitensis) is conducted on Nicasio Ridge once or twice a year as funding allows. At this time, however, these non-native species do not appear to pose a serious threat to the Nicasio Ridge C. affinis ssp. neglecta occurrence (M. Chasse personal communication 2011). Treatments for barbed goatgrass (Aegilops triuncialis) have taken place on the Kirby Canyon Butterfly Preserve that supports Paintbrush Hill occurrence of C. affinis ssp. neglecta in Santa Clara County (Niederer 2008) and a number of non-native species occur in low densities within the North Canyon occurrence in Santa Clara County (C. Niederer personal communication 2009). At these two locations, efforts to control non-native plant species are necessary to keep them in control, but at this 14 time cattle grazing and current efforts appear to have prevented severe encroachment of non-native species (C. Niederer personal communication 2009). (USFWS, 2012)

**Stressor:** Nitrogen Deposition (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Air pollution and the resultant deposition of reactive airborne nitrogen has become a significant threat to many native California plants, in particular to those that occur in nutrient poor soils such those in serpentine areas (Weiss 1999). Increased nitrogen deposition allows nutrient-poor serpentine soils to be invaded by non-native annual grasses that displace the native forbs (Weiss 1999). Nitrogen deposition is especially high near urban areas where combustion sources produce substantial concentrations of nitrogen oxides (Weiss 1999). All occurrences of Castilleja affinis ssp. neglecta occur within or adjacent to urban areas with elevated levels of nitrogen deposition with particularly high nitrogen deposition levels occurring in Santa Clara County near San Jose (Weiss 2006). (USFWS, 2012)

**Stressor:** Stochasticity (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The limited number and small sizes of Castilleja affinis ssp. neglecta occurrences increase this species vulnerability to chance events such as fire, flood, drought, disease, and other natural and human-caused disasters (Brook et al. 2002). The occurrences of C. affinis ssp. neglecta on the Tiburon peninsula in particular are located in close proximity to dense, residential development placing them at risk of catastrophic events associated with human activity such as fire or vandalism. In addition, small populations are subject to inbreeding (mating between closely related individuals) resulting in a subsequent loss of genetic diversity (Spielman et al. 2004). Small populations are also more likely to experience extinction as a result of “stochastic” demographic fluctuations or other density-dependent effects (Avise 2004). (USFWS, 2012)

**Stressor:** Climate Change/Drought (USFWS, 2012)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. The models suggest that shifts in species ranges may break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). While it appears reasonable to assume that Castilleja affinis ssp. neglecta will be affected by climate change, we lack sufficient certainty regarding how and how soon climate change will affect the species. Because C. affinis ssp. neglecta is restricted to limited and patchily distributed serpentine soils, however, the species will likely have difficulty shifting its range to adjust to changing conditions. (USFWS, 2012)

***Recovery***

**Reclassification Criteria:**
1. Six (6) populations of Castilleja affinis ssp. neglecta are fully protected and managed with the primary intention of preserving the populations in perpetuity (USFWS, 1998)

2. Six (6) populations of Castilleja affinis ssp. neglecta are shown to be stable or increasing with evidence of recruitment over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 1998)

3. Seed collected from natural populations throughout the range of the species is stored at a minimum of two Center for Plant Conservation certified botanic gardens (USFWS, 1998)

4. Reliable seed germination and propagation techniques for the species are understood (USFWS, 1998)

Recovery Priority Number: 9C

**Delisting Criteria:**
1. Ten (10) populations throughout its range are shown to be fully protected and managed with the primary intention of preserving the populations in perpetuity. At least 2 of the 10 should occur in Santa Clara County. (USFWS, 1998)

2. Ten (10) populations of Castilleja affinis ssp. neglecta are shown to be stable or increasing with evidence of recruitment over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 1998)

3. Seed collected from natural populations throughout the range of the species is stored at a minimum of two Center for Plant Conservation certified botanic gardens (USFWS, 1998)

4. Reliable seed germination and propagation techniques for the species are understood (USFWS, 1998)

**Recovery Actions:**

- Protecting and managing the known populations. Protection and management of populations on public lands will involve working with Main Open Space District, the town of Tiburon, and the Golden Gate National Recreation Area to ensure the long-term survival of the species on their lands. The populations, or portions of populations, occurring on private lands should be protected by land acquisition, conservation easements, or other mechanisms. Among populations on private land, protection of the only known population in Santa Clara County is a particularly high priority because it is geographically disjunct from other populations. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In addition, other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing Castilleja affinis ssp. neglecta and other special status species in each location must be developed and implemented. The plans should include provisions for standardized monitoring of Castilleja affinis ssp. neglecta populations every other year to determine demographic trends. The plans should also include strategies to minimize known threats (e.g. foot traffic) at the sites as well as to identify new threats should they appear. Removal of nonnatives should be a high priority for management of sites on the Tiburon Peninsula such as those on Middle Ridge and in Main County Open Space near Old St. Hilary's Church. In addition, soil slumping at the Ring Mountain Preserve needs to be minimized. If new threats are identified or other new information becomes available, management plans need to be reevaluated and revised. For populations on public lands, any management plan developed should include an educational outreach program. (USFWS, 1998)
- Collection and banking of seed in Center for Plant Conservation certified botanic gardens. Seed banking guards against extinction of populations from chance catastrophic events and provides potential material for enhancement efforts in existing populations, repatriations, and/or introductions to new sites. In the absence of genetic data for Castilleja affinis ssp. neglecta, seed collection efforts should represent populations throughout the range of the species, including the Santa Clara County population that is at least 100 kilometers (62 miles) south of the other known populations (Elam in prep). Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
- Other potential serpentine habitat throughout the range of the species should be surveyed to determine if other populations exist. Santa Clara County, in particular, contains habitat that should be surveyed (e.g. to the south of the known occurrence and in Henry Coe State Park east of Anderson Reservoir) (California Department of Fish and Game 1 997a). If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. (USFWS, 1998)
- The effect of various vegetation management techniques (e.g. grazing, mowing, and burning) on Castilleja affinis ssp. neglecta needs to be evaluated, because (1) Castilleja affinis ssp. neglecta occurs approximately 100 to 250 meters (328 to 820 feet) from relatively good quality bay checkerspot butterfly habitat (N. McCarten, in litt., 1998) in Santa Clara County, and (2) bay checkerspot butterfly habitat benefits from vegetation management,. Although cattle and deer grazing of Castilleja affinis ssp. neglecta has not been observed (N. McCarten, in litt., 1998), evaluation of these techniques will ensure that

managers select management strategies that maintain bay checkerspot butterfly habitat while not adversely affecting Castilleja affinis ssp. neglecta. Research on the effects of grazing are also important in recovery efforts for Castilleja affinis ssp. neglecta because grazing is a concern at the Golden Gate National Recreation Area in Main County. In addition, because other Castilleja species appear to benefit from fire (R. Raiche. cited in California Department of Fish and Game 1997b, small scale experimental burning (e.g. using burn boxes) may reveal another possible management strategy. Any experimental burning should initially be limited to a very small area (e.g. 1 square meter [10.8 square feet]). (USFWS, 1998)

- Other research needs include germination and propagation techniques, taxonomic, demographic, and genetic studies as well as mating system and pollination studies. Demographic studies should include field studies of Castilleja affinis ssp. neglecta's hemiparasitic nature, the frequency of seed germination and seedling recruitment in nature. and identification of limiting life history stages. Martin (1989) observed no seedlings in the field during a 2-year study. Genetic studies should focus on whether, and to what extent, populations throughout the range of the species are genetically different from one another. These genetic data would be valuable guides as to which populations should be chosen as sources for enhancement of existing populations or introduction of new populations. (USFWS, 1998)
- Control and eradicate non-native, invasive plant species: continue to control non-native plant species at Ring Mountain Preserve and Town of Tiburon Open Space parcels according to existing management plans. Amend the Town of Tiburon Open Space Management Plan to include the Old Saint Hilary's Church Open Space parcel. Develop and implement management plans for controlling non-native invasive plant species in the area supporting the two Castilleja affinis ssp. neglecta occurrences on GGNRA land in Marin County, on the Newell Preserve in Napa County, and for the mitigation lands supporting the two C. affinis ssp. neglecta occurrences in Santa Clara County. (USFWS, 2012)
- Locations that should be targeted for protection in cooperation with willing landowners: in Santa Clara County, establish a conservation easement on the 250 acre Bay checkerspot butterfly reserve that supports the Paintbrush Hill C. affinis ssp. neglecta occurrence and on the entire mitigation parcel that supports the North Canyon occurrence. In Napa County, pursue opportunities to acquire or incorporate land supporting C. affinis ssp. neglecta in the former quarry area into Newell Open Space Preserve. In Marin County, establish a conservation easement on all remaining undeveloped serpentine habitat in the Old St. Hilary's Church area as mitigation for any development that takes place on private parcels in this location. (USFWS, 2012)
- Monitoring: Continue to monitor Castilleja affinis ssp. neglecta on the Ring Mountain Preserve using the 24 established 1m2 monitoring plots for three years using the same parameters as those used in 2007 thereafter, every two years as recommended by the 1998 Recovery Plan (Service 1998). Add a monitoring protocol for Castilleja affinis ssp. neglecta to the Town of Tiburon Open Space Management Plan. In Marin County on GGNRA land, continue monitoring Castilleja affinis ssp. neglecta at Nicasio Ridge and initiate monitoring at CNDDB occurrence 6. Include monitoring of grazing effects at these locations. (USFWS, 2012)
- Seeds from Castilleja affinis ssp. neglecta should be collected from populations throughout the range and banked in Center for Plant Conservation certified gardens. (USFWS, 2012)

- Other serpentine habitats with the potential to support Castilleja affinis ssp. neglecta should be surveyed to determine whether undiscovered populations exist. New populations should be noted with the appropriate County, California Department of Fish and Game, the Service and the California Native Plant Society. (USFWS, 2012)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: In this section we propose recommendations which will aid in the recovery and conservation of Tiburon paintbrush. Some of these recommendations have already been discussed in previous recovery documents (Service 1998; Service 2012) and have been carried over into this status review. 1) Continue to control and eradicate non-native, invasive plant species. Use existing management plans or develop and implement management plants including controlling nonnative invasive species for all protected areas. 2) In cooperation with willing landowners, target protection of Tiburon paintbrush occurrences on unprotected lands. Continue to work with partners to protect occurrences on private lands, including buffers around them when possible. In particular, pursue opportunities to permanently protect land supporting Tiburon paintbrush in the former quarry area adjacent to the Newell Open Space Preserve in Napa County, and the area immediately east of the Golden Gate National Recreation Area land at Nicasio Ridge in Marin County. 3) Monitor or continue to monitor all existing Tiburon paintbrush occurrences using a consistent protocol. Implement survey protocols carefully to minimize damage to plants (e.g., if attempting to distinguish individual plants) or trampling from group visits. 4) Survey additional serpentine habitats with the potential to support Tiburon paintbrush to determine whether undiscovered populations exist. Habitat suitability studies or iterative niche modeling could be used to identify potential habitat areas. New populations should be noted with the appropriate County, California Department of Fish and Wildlife, the Service, and the California Native Plant Society. 5) Seeds from Tiburon paintbrush should be collected from populations throughout the range and banked in Center for Plant Conservation certified gardens. Priority should be placed on populations that do not yet have seeds banked. 6) Conduct or continue research on Tiburon paintbrush. Continue research on host plants, including testing additional species and host plant preference, and on seed germination. Identify environmental factors that might influence suitability of the habitat in occupied areas (and that might explain absence from other areas). Continue evaluation of exclosures to prevent grazing/rooting and, depending on results, consider additional exclosures or a fence around the Paintbrush Hill population. (USFWS, 2021)

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# SPECIES ACCOUNT: *Castilleja campestris ssp. succulenta* (Fleshy owl's-clover)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 03/26/1997; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A hemiparasitic annual herb, mostly 5-25 cm tall, with fleshy, somewhat brittle leaves. Produces dense inflorescences of yellow to white flowers subtended by green bracts. (NatureServe, 2015)

**Taxonomy**

Both Kartesz and the Fed. Reg. agree on the nomenclature of this element and now recognize it as part of the genus Castilleja (as opposed to Orthocarpus). (NatureServe, 2015)

**Historical Range**

The historical distribution between 1937 and 1986 was reported from 33 occurrences (Hoover 1937, 1968, CNDDB 2005), all in the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf et al. 1998). Sixteen of those occurrences, including the type locality, were in eastern Merced County. Six occurrences each were in Fresno and Madera Counties and five others were in Stanislaus County (CNDDB 2003). (USFWS, 2011)

**Current Range**

Succulent owl's-clover is geographically distributed in vernal pool complexes that are primarily along the lower foothill grasslands of the eastern San Joaquin Valley. Within the San Joaquin Valley, the succulent owl's-clover is distributed throughout five counties: San Joaquin, Stanislaus, Merced, Madera, and Fresno Counties. The species is also found in the southeastern Sacramento Valley within San Joaquin County. The current species range is approximately 50 kilometers (31 miles) wide from east to west, and 243 kilometers (151 miles) long from north to south. While the range of succulent owl's-clover has expanded since it was described at listing, the current species distribution is similar to what we described in our 2011 review (USFWS, 2023)

**Critical Habitat Designated**

Yes; 2/10/2006.

**Legal Description**

On August 6, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Castilleja campestris ssp. succulenta (Fleshy owl's-clover) (and other vernal pool species) under the Endangered Species Act of 1973, as amended (Act) (68 FR 46684 - 46867). On August 11, 2005, the Service issued a Final Rule that excluded some lands addressed in the 2003 rule from the final designation for economic reasons (70 FR 46924 - 46999). On February 10, 2006, the Service issued administrative revisions to the Final Rule (71 FR 7118-7316). The critical habitat designation for Castilleja campestris ssp. succulenta includes six critical habitat units (CHUs) in California.

**Critical Habitat Designation**

The critical habitat designation for Castilleja campestris ssp. succulenta includes six CHUs (some with multiple parts) in Fresno, Madera, Mariposa, Merced, San Joaquin, Stanislaus, and Tuolumne Counties, California. This species critical habitat encompasses approximately 175,873 acres (68 FR 46684 - 46867; 70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Sacramento and San Joaquin Counties, California. From USGS 1:24,000 scale quadrangles Clay and Lockeford.

Unit 2: Tuolumne and Stanislaus Counties, California. From USGS 1:24,000 scale quadrangles Keystone, La Grange, Cooperstown and Paulsell.

Unit 3: Mariposa and Merced Counties, California. (i) Unit 3A: Mariposa and Merced Counties, California. From USGS 1:24,000 scale quadrangles Merced Falls and Snelling.

Unit 3B: Mariposa and Merced Counties, California. From USGS 1:24,000 scale quadrangles Merced Falls, Snelling, Indian Gulch, Haystack Mountain, Yosemite Lake, Winton, Owen's Resevoir, Planada and Merced.

Unit 4: Madera and Merced Counties, California. (i) Unit 4A: Madera and Merced Counties, California. From USGS 1:24,000 scale quadrangle Raynor Creek.

Unit 4C: Madera and Fresno Counties, California. From USGS 1:24,000 scale quadrangles Millerton Lake West, Little Table Mountain, Daulton, Friant, Lanes Bridge and Gregg.

Unit 5: Fresno County, California. (i) Unit 5A: Fresno County, California. From USGS 1:24,000 scale quadrangles Friant and Round Mountain.

Unit 5B: Fresno County, California. From USGS 1:24,000 scale quadrangle Clovis.

Unit 6: Fresno County, California. (i) Unit 6A: Fresno County, California. From USGS 1:24,000 scale quadrangles Millerton Lake East and Academy.

Unit 6B: Madera County, California. From USGS 1:24,000 scale quadrangles North Fork and Millerton Lake East.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The primary constituent elements of critical habitat for Castilleja campestris ssp. succulenta (Fleshy owl's-clover) are the habitat components that provide:

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described in paragraph (c)(8)(ii) of this section, providing for dispersal and promoting hydroperiods of adequate length in the pools; and

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

**Special Management Considerations or Protections**

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/or primary constituent elements in adjacent critical habitat.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (annuals) (USFWS, 2011)

**Breeding Season**

Adult: April and May (USFWS, 2011)

**Reproduction Narrative**

Adult: Castilleja campestris ssp. succulenta is an annual plant. Seeds of the C. campestris ssp. succulenta do not require the presence of a host to germinate, as they form root connections only after reaching a seedling stage.

**Habitat Type**

Adult: Vernal pools (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Small, seasonal pools. (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occur at elevations of 24 m (80 feet) to 700 m (2,300 feet). (USFWS, 2011)

**Spatial Arrangements of the Population**

Adult: Widely scattered (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2011; NatureServe, 2015)

**Habitat Narrative**

Adult: Castilleja campestris ssp. succulenta is found primarily in vernal pools, and only in the lower rolling foothill areas of the eastern San Joaquin Valley in the Southern Sierra Foothills

Vernal Pool Region (Service Recovery Plan 2005). Soil textures at those sites range from extremely stony loam to loamy clay. At the U.C. Merced site and the surrounding community planning area, 81.4% of the individual pools where this taxon was found were on Redding gravelly loam, 9.5% were on Corning gravelly sandy loam, 6.4% were on Corning gravelly loam, 1.7% were on Keyes gravelly loam, 0.7% was on Keyes gravelly clay loam, and 0.3% was on Pentz loam (EIP Associates 1999). Self-pollinating species of Castilleja typically occur as widely scattered individuals, rather than dense colonies (Atsatt 1970). Populations of Castilleja campestris spp. succulenta have been reported from elevations of 24.0 m (80 feet) at the San Joaquin County site to 700.0 m (2,300 feet) at Kennedy Table in Madera County (CNDDB 2003). (USFWS, 2011; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Number of Populations:**

99 presumed extant occurrences (USFWS, 2023)

**Adaptability:**

Low (inferred from USFWS, 2011)

**Population Narrative:**

The Department (2020, pp. 9–10) defines an element occurrence (also known as an EO and hereafter, occurrence) in the Diversity Database as a specific location where a special status species has been known to occur. A single occurrence can contain multiple distinct sites (i.e., multiple interconnected pools within a single pool complex) where the species occurs. Generally, populations, individuals, or colonies located within a quarter mile of each other constitute a single occurrence. Geographic boundaries or polygons associated with each occurrence can change as additional data is received (Department 2020, p. 10). At the time of listing, the succulent owl's-clover was distributed over 36 extant occurrences throughout Merced, Fresno, Madera, Stanislaus, and San Joaquin Counties (Service 1997, p. 14349). The 2011 5-year review reported 99 occurrences throughout the same counties as those at listing but also included Mariposa County. Nine of those occurrences, which were not identified by occurrence number, were reported as extirpated and 90 were presumed extant (Service 2011, p. 6). The increase in occurrences was attributed to an increase in the number of surveys following listing (Service 2011, p. 8). In 2023, there are 99 reported occurrences that are presumed extant, two of which are possibly extirpated (occurrence numbers 1 and 7) (Diversity Database 2023, pp. 1, 8). None of the current occurrences are described as extirpated and it is unclear which occurrences were previously described as extirpated or why their status was changed. Since the previous 5-year review, 12 new occurrences have been reported for succulent owl'sclover to the Diversity Database (occurrence numbers 100–111) and additional locations have been identified that are not currently in the Diversity Database. However, these additional occurrences are located within the existing range of the species and do not change our understanding of the species' distribution. Furthermore, three previous occurrences reported in 2011 (occurrence numbers 63, 81, and 82) have been added to nearby occurrences in the Diversity Database.

Number 63 has been added to occurrence number 27, number 81 has been added to occurrence number 79, and number 82 has been added to occurrence number 80 (Diversity Database 2023, pp. 25, 72, 73). Again, it is unclear why there is a discrepancy between the number of occurrences reported during the 2011 5-year review and the number of occurrences reported currently. Abundance: At the time of listing, there were 24 occurrences of succulent owl's-clover that had associated plant number estimates and approximately 10 of these occurrences contained fewer than 100 plants each at their peak size (Service 2011, p. 14). Occurrence data was not used in the 2011 5- year review to determine plant population trends due to inconsistently documented plant numbers recorded during surveys and fluctuations of data from year to year (Service 2011, p. 14). However, the 2011 5-year review noted that as of 2009, Diversity Database records showed that 35 occurrences contained plant number estimates with 16 occurrences having fewer than 100 plants and 17 occurrences with more than 100 plants (Service 2011, p. 14). According to the Diversity Database (2023) and additional sources (identified in Table 1), 17 out of 99 presumed extant succulent owl's-clover occurrences have been surveyed since the last 5-year review. Survey data for these occurrences are detailed below in Table 1 and summarized by county in the following subsections (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat degradation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 1997 final rule stated that nearly half of the extant Castilleja campestris ssp. succulenta occurrences are threatened by man-made activities such as urbanization, agricultural land conversion, discing, trampling due to overgrazing, mining, and a proposed road expansion project. The threats presented in the listing rule are still relevant. The habitat of this species has been reduced and fragmented throughout its range and vernal pools continue to be removed by the factors previously noted. Lands on the Central Valley floor are closer to existing cities and agricultural lands than the valley rim, which is steeper, less fertile and more removed from cities. As a result, valley floor vernal pools, along with open rangeland, have been and continue to be favored for urban and agricultural development. (USFWS, 2011)

**Stressor:** Stressor
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** According to a University of California, Berkeley study, the native plants unique to California are vulnerable to global climate change and that two-thirds of these endemics could suffer more than an 80% reduction in geographic range by the end of the century (U.C. Berkeley Press Release, June 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). It is unknown at this time if climate change in California specifically will result in a warmer trend with localized drying, higher precipitation events, or other effects. (USFWS, 2011)

**Stressor:** Small population size
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Since the final listing rule, an additional threat to Castilleja campestris ssp. succulenta is that many of its populations are small in number. A small population size makes a population more vulnerable to extirpation from chance events as noted in the 2005 Recovery Plan. Among the 24 occurrences of C. campestris ssp. succulenta for which size estimates had been documented, ten consisted of fewer than 100 plants each at their peak size (J. Stebbins in litt. 2000b, CNDDB 2003). According to the 2009 CNDDB occurrences, 35 have population size estimates documented with approximately 16 occurrences with fewer than 100 plants and approximately 17 occurrences with more than 100 plants.

**Stressor:** Rainfall
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This taxon is very cyclical and is somewhat scarce in normal or below normal rainfall years but large populations may be evident in wet years at the known sites (J. Stebbins, pers. comm. 2009). (USFWS, 2011)

**Stressor:** Habitat Loss (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Of the three counties analyzed in the Vollmar et al. (2013, p. 28) study, vernal pool grassland habitats in Merced County have experienced the lowest loss of predicted extant habitat for succulent owl's-clover. This lower loss of predicted habitat is likely due to the relatively protected nature of the succulent owl's-clover's primary preferred habitat in high terrace terrain that is not as conducive to conversion for agriculture or development, such as the secondary preferred habitat in lower terrace terrain (Vollmar et al. 2013, p. 28). As of 2010, a total of 54,971 acres of extant succulent owl's-clover habitat was predicted to remain within the core recovery areas in Merced County, and a total of 5.6% (3,198 acres) of extant habitat is predicted to have been lost between 2005–2010 (Vollmar et al. 2013, p. 31). The primary cause of vernal pool habitat loss in Madera and Merced Counties is a result of conversion for agricultural uses and development (Vang et al. 2012, p. 30; Witham 2021, p. 8). However, outside of vernal pool preservation, there are some lesser-degree protections in place for the extant vernal pool habitat that lies within portions of the Great Valley. For example, while most private lands that contain high-quality vernal pool habitat adjacent to the Madera and Friant-Kern canals are not associated with conservation easements or other protections, most extant rangeland along the canals is under contracts with local government under the California Land Conservation Act of 1965 (also known as the Williamson Act), which means land use is restricted to agricultural or open space use and such restrictions can help to limit development and habitat loss (USFWS, 2023).

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

**Narrative:** As described in the 2011 5-year review, climate change has the potential to alter the timing and synchronicity of ecosystem processes, including the germination, growth, and pollination of succulent owl's-clover. The core areas in the Recovery Plan were developed, in part, using current known habitat boundaries for the species; however, possible new areas of suitable habitat may eventually arise because of worsening climate change and altered weather patterns (Service 2005, p. I-25). This could in turn contribute to shifts in the abundance or composition of vernal pool plant communities. Over the 21st century, global climate models predict higher temperatures, increasing potential evapotranspiration from plants and soils, longer and more severe droughts, declining snowpack, more intense precipitation events, more frequent and extensive wildfires, and sea level rise (Fernandez-Bou et al. 2021, p. 17). Worldwide, plants with less static ecosystem requirements are generally responding to climate change patterns by redistributing to higher altitudes, cooler areas of higher latitudes, and areas with higher precipitation, to seek refuge from rising temperatures and drought conditions (Shay et al. 2021, p. 2). Data is limited on how vernal pool plant communities and distributions may respond to increasing threats from global climate change. However, studies have begun to expand focus to identify the possible effects to plant phenology and species ranges that could arise from climate change. Historical data in the San Joaquin Valley from 1961 to 1990 show an increase in average maximum temperatures by about 1 degree Fahrenheit (0.5 degree Celsius); temperatures in the Valley are projected to continue to increase 4 to 5 degrees Fahrenheit (2.2 to 2.7 degrees Celsius) by 2050, and 5 to 8 degrees Fahrenheit (2.7 to 4.4 degrees Celsius) by the end of the century, depending on what level of emissions are actively reduced over time (Fernandez-Bou et al. 2021, p. 18). Recent research was conducted using the creation of hydrology and vegetation models to predict how climate change will impact volcanic vernal pools in northern California (Montrone et al. 2019, pp. 9–23). Simulation output suggests that higher localized seasonal temperatures would contribute to increased evaporation and shorter hydroperiods in vernal pools. This effect could lead to declines of the long-term inundated plant community, and conversely, edge and shallow-tolerant plant communities would increase (Montrone et al. 2019, p. 27). Within the warmer San Joaquin Valley, shorter hydroperiods in vernal pools could lead to competition and encroachment on succulent owl's-clover from nonnative invasive annual grasses and forbs that are less adapted to periodic inundation (Rains et al. 2006, p. 20; Javornik and Collinge 2016, pp. 65–66). Restoration and conservation efforts conducted over the next century in the San Joaquin Valley will need to be sited (and timed within the growing season) to focus on how changes in local precipitation and temperature patterns can impact the success of these efforts (USFWS, 2023).

**Stressor:** Pesticide Use (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because the agriculture industry is so prevalent throughout the southern Sierra foothills, research is becoming increasingly important to analyze potential effects of pesticide use on vernal pool grassland ecosystems and pollinators. The Environmental Protection Agency recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (EPA 2022a, entire; EPA 2022b, entire; EPA 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. All three pesticides were determined likely to adversely affect succulent owl's-clover, primarily due to expected indirect effects to pollinators. The three pesticides target insect species by acting on

their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. The three pesticides are highly toxic to bees and available data suggest that all three pesticides are likely to affect honeybee and bumblebee colonies through brood reduction and declines in numbers of adults. However, the overall importance of pollinating insects for succulent owl's-clover is poorly understood. Some aspects of succulent owl's-clover biology suggest that it may be selfpollinating, but many species related to this taxon are pollinated by generalist bees (Superfamily Apoidea) (Chuang and Heckard 1991, p. 648). Analysis of these insecticides' effects to vernal pool habitat and species is ongoing (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
1. Habitat protection - Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Reintroductions must be carried out and meet success criteria established in the Recovery Plan. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to the recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the Recovery Plan. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2011)

2. Adaptive habitat management and monitoring: Habitat management and monitoring plans that ensure maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected. Mechanisms are in place to provide for long-term management and monitoring. Monitoring indicates ecosystem function has been maintained in the areas protected. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recover criteria. (USFWS, 2011)

3. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated. (USFWS, 2011)

4. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species

biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully represented by populations protected in the Habitat Protection section. Research necessary to determine appropriate parameters to measure population viability for each species has been completed. (USFWS, 2011)

5. Participation and outreach: recovery implementation team is established and functioning to oversee range-wide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships. (USFWS, 2011)

**Delisting Criteria:**
Same as the reclassification criteria.

**Recovery Actions:**
- Conduct standardized vernal pool habitat site assessments for both the Southeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions. (USFWS, 2011)
- Establish management and monitoring plans which include criteria for frequent surveys in order to capture the blooming period for this species. The Castilleja campestris ssp. succulenta population numbers vary widely from year to year depending on habitat conditions and rainfall (Vollmar 2002). Therefore, the Service should encourage bank owners and preserve managers to perform surveys on a frequent schedule in order to gather additional data which will increase knowledge. The additional information will be utilized for future 5-year reviews. (USFWS, 2011)
- The Vernal Pool Regional working group should formulate a plan to reach out and educate private landowners as to the value of federally-listed species on their lands, with a particular focus on plants. The Vernal Pool Regional group also should provide guidance to assist landowners on how to better manage their lands for the overall benefit of this species. (USFWS, 2011)
- The Service should encourage collection of seeds and storage in approved seed banks from extant occurrences, in each core area, to aid in the establishment of a seed bank. (USFWS, 2011)
- The Service should encourage County and local governments to consider developing Habitat Conservation Plans (HCPs) to include vernal pool species. Take of a federally listed invertebrate species would be permitted on private land, and any habitat acquisition to compensate for invertebrate species could include the Castilleja campestris ssp. succulenta if appropriate. Fresno County has been awarded Federal funds for the development of an HCP and additional funds may be available in the future for counties who apply for them. (USFWS, 2011)
- Efforts to protect vernal pool species should include conservation efforts on a landscape scale (Vollmar 2002). Landscape Conservation Cooperatives provide Federal scientific and technical support for conservation on a landscape scale which is the entire range of an

identified priority species. These cooperatives also have a role in helping partners identify common goals and priorities to target the right science for efficient and effective conservation. (USFWS, 2011)

- Not available

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the succulent owl’s-clover. Some of these recommendations have already been discussed in previous recovery documents (Service 2005, p. ix–xii) and the previous 5-year review (Service 2011, pp. 22–23) and remain valid. 1. Research. Research is needed to determine whether succulent owl’s-clover is insectpollinated. If insects are found to be important to pollination and therefore to seed production, pollinator habitat must be protected in each core area to contribute to the recovery of the species (Service 2005, p. III-13). 2. Invasive plant management. Continue to control and eradicate non-native, invasive (noxious) grass and forb species. Use existing management plans or develop and implement management plans that include control of invasive plants for all protected areas. 3. Expand survey effort for succulent owl’s-clover to determine whether undiscovered populations exist. Conduct standardized vernal pool habitat site assessments for both the Southeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions. A standardized monitoring plan should be used to assess hydrology at the known extant occurrences throughout the species’ range. Federal and State agencies, partners, and a San Joaquin Valley recovery team should create a forum of discussion with a prioritized goal of identifying updated conservation issues and potential incentives for private landowners to become more willing to participate in conservation and surveying efforts. 4. In cooperation with willing landowners, target protection of succulent owl’s-clover occurrences on unprotected lands. Apply updated study methods for identification of key areas of remaining habitat and conduct floristic surveys in core areas of the succulent owl’s-clover range. Develop predicted habitat maps for the entire range of succulent owl’s-clover to aid in conservation planning and species recovery of this species. 5. Seed Banking. The Service should encourage collection of seeds and storage in approved ex situ seed banks (such as the Santa Barbara Botanic Garden) from extant occurrences, in each core area in each vernal pool region, to aid in the establishment of a seed bank (USFWS, 2023).

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# SPECIES ACCOUNT: *Castilleja mollis* (Soft-leaved paintbrush)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/31/1997; California/Nevada Region (R8) (USFWS, 2015)

**Physical Description**

A shrubby, hemiparasitic, perennial herb with soft-woolly, grayish-green foliage. The highly branched plants are somewhat prostrate, usually reaching only 3+ dm high. Inflorescences (April-August) have yellow bracts (the bracts much more conspicuous than the flowers). (NatureServe, 2015)

**Taxonomy**

This species was described by Pennell as Castitteja moltis in 1947, based on material collected on Santa Rosa Island in 1939 (Ingram 1990, Heckard et at. 1991). Hoover (1970) and Munz and Keck (1973) included plants of coastal sand dunes of San Luis Obispo County in the description of this taxon. (USFWS, 2000). Upon review and in agreement with available systematic and floristic literature and consultation with species experts, we intend to propose amending part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations to reflect the transfer of Castilleja taxa including C. mollis from the family Scrophulariaceae to the family Orobanchaceae. (USFWS, 2007)

**Historical Range**

See current range/distribution.

**Current Range**

Castilleja mollis (Orobanchaceae) is a perennial herb that occurs only on Santa Rosa Island in Santa Barbara County, California, about 25 miles (40 kilometers) from the mainland. Santa Rosa Island is owned by CINP and is managed primarily for natural resource conservation (USFWS, 2023).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (hybridization) NatureServe, 2015)

**Breeding Season**

Adult: April to August (NatureServe, 2015)

**Other Reproductive Information**

Adult: This plant occasionally hybridizes with Castilleja affinis. (NatureServe, 2015)

**Reproduction Narrative**

Adult: This plant occasionally hybridizes with Castilleja affinis. Inflorescences (April-August) have yellow bracts (the bracts much more conspicuous than the flowers). (NatureServe, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Sand/dune, Shrubland/chaparral (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Dependency on Other Individuals or Species for Habitat**

Adult: Soft-leaved paintbrush is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (Isocoma menziesii var. sedoides) (E. Painter in titt. 1995, M. Wetherwax in titt. 1995). (USFWS, 2000)

**Habitat Narrative**

Adult: It is well established that Castilleja mollis requires the coastal scrub bluff community, which includes goldenbush, to establish and survive (USFWS, 2000). Castilleja mollis requires stabilized and partially stabilized coastal dunes (NatureServe, 2015). Castilleja mollis is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (Isocoma menziesii var. sedoides) (E. Painter in titt. 1995, M. Wetherwax in titt. 1995). (NatureServe, 2015; USFWS, 2000)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Fluctuating populations (USFWS< 2023)

**Population Growth Rate:**

Slow decline (NatureServe, 2015)

**Number of Populations:**

2 (USFWS, 2023)

**Population Size:**

>1000 (NatureServe, 2015)

**Population Narrative:**

Historically and currently, C. mollis has been found in two populations on the north side of Santa Rosa Island which are separated by about 10 miles (16 kilometers): Carrington Point and Jaw Gulch (Table 2). Identification by California Natural Diversity Database Element Occurrence Number (CNDDB EO #) has never been used by staff at CINP or USGS to identify the populations. The species has been extirpated from San Miguel Island, and two other locations reported by CNDDB are in error (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Decline of plant host (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** We have information that indicates the direct dependency of Castilleja mollis on the coastal goldenbush scrub community (McEachern, pers. comm. 2006a). Before 1998, cattle grazing and ungulates rutting caused large gaps in the coastal goldenbush community. These gaps were then invaded by non-native grasses, inhibiting Castilleja mollis from making root connections with the goldenbush host plant. (USFWS, 2007)

**Stressor:** Non-native plants (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition with non-native plant taxa was also identified as a threat to Castilleja mollis in the final recovery plan (U.S. Fish and Wildlife Service 2000). Castilleja mollis is forced to compete with the invasive annual grasses for water and nutrients. This competition weakens the paintbrush, which may contribute to the failure of seedlings to make root connections with the goldenbush host plant (McEachern 2004a). (USFWS, 2007)

**Stressor:** Soil disturbance and trampling (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although all cattle have been removed from Santa Rosa Island and deer numbers have decreased, elk numbers have increased since 2001 (see Figures 2 and 3). This is believed to be a continuing factor hindering Castilleja mollis recovery on the island (McEachern 2003). (USFWS, 2007)

**Stressor:** Habitat fragmentation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Past habitat fragmentation that occurred as a result of grazing and trampling is still considered a major threat to the species. (USFWS, 2007)

**Stressor:** Predation (USFWS, 2007)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** The listing rule also noted cattle herbivory as a problem for the species, but cattle were removed from Santa Rosa Island in 1998. Cattle removal and the reduction in the number of deer have, so far, not resulted in substantial improvements in Castilleja mollis. (USFWS, 2007)

**Stressor:** Soil disturbance and trampling (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Trends in the number of inflorescences and percent cover suggest that a large-scale event, such as weather, may also influence flowering and growth (McEachern, in litt. 2006b; McEachern, pers. comm. 2006c). (USFWS, 2007)

**Stressor:** Stochastic events (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Due to the small population size of this species, the listing rule noted that Castilleja mollis would be vulnerable to stochastic events (including variable weather patterns such as drought), reduced genetic integrity of the species, and depressed reproductive vigor (62 FR 40957). (USFWS, 2007)

**Stressor:** Climate change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes in climate could threaten C. mollis in several ways. First, as vegetation shifts with climate change, the species might not be able to disperse to suitable germination or recruitment habitat, as is predicted to happen to island annuals (Levine et al. 2008 p. 796). Second, the proper combination of environmental cues for germination could occur less frequently or not at all, decreasing germination and causing declines in abundance and possible extirpations (Levine et al. 2008 pp. 800–805; Levine et al. 2011 pp. 2241–2246). Expected climate change for the geographic region of the islands predicts both rising annual temperatures (Langridge 2018 pp. 13–15) and less frequent, more episodic rainfall (Langridge 2018 pp. 16–17). Preliminary analysis of demography and environmental data (HasenstabLehman et al. 2022) show that the C. mollis individuals have lower survival in hotter years, with Jaw Gulch plants more negatively affected by higher temperatures than are Carrington Point plants, so climate change induced temperature rise is a threat to the species. Additionally, the species is found at less than 20 meters or 66 feet elevation. Sea level may rise by about 0.25 m (1 ft) by 2050 (Sweet et al. 2022 p. 19) and 1.0 m (3 ft) by 2100 (Sweet et al. 2022 p. 23). The low elevation habitat in which C. mollis is found is largely unprotected from the effects of rising sea level, and at least the lowest elevation plants might be threatened by inundation or removal by wave action in the future. Another prediction with increasing annual temperature in California is an increasing dominance by non-native annual grasses (Sandel and Dangremond 2012, entire) in certain situations. If nonnative grass cover increases further, the presumed competitive effects of increased grass cover would further threaten C. mollis. (USFWS, 2023)

**Stressor:** Increased visitor use (USFWS, 2023)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Implementation of the preferred alternative in the Channel Islands General Management Plan (2015, pp. 165–173) would facilitate easier visitor access to the backcountry of Santa Rosa Island. If this results in increased hiker use of the relatively level and scenic marine terraces of the Jaw Gulch area, the genetically distinct and possibly declining population of C. mollis there could be detrimentally impacted by trampling by hikers or unauthorized camping in the area. Additionally, at Carrington Point the species has been recently found on both sides of a popular hiking trail (K. McEachern pers. comm.), and could be trampled by hikers. The final impact of increased visitor use will likely be determined by the CINP Backcountry Wilderness Management Plan, which is under development, and until it is finalized, the magnitude of the threat of increased visitor use to the species is unknown (USFWS, 2023).

**Stressor:** Insect damage to inflorescences (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since introduced in the 2007 5-year review, no further work has been done on the effects of insect damage to C. mollis inflorescences, and the magnitude of this threat remains (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
1. Maintain the existing distribution with multiple colonies in each population on Santa Rosa Island. (USFWS, 2000)

2. Maintain stable or increasing population trends with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle. (USFWS, 2000)

3. Damage from normative mammals significantly reduced. (USFWS, 2000)

Recovery Priority Number: 2

**Delisting Criteria:**
1. Expansion of individuals into potential habitat within population boundaries. (USFWS, 2000)

2. No decline after downlisting for 10 years. (USFWS, 2000)

3. All potential habitat surveyed.

**Recovery Actions:**
- Provide protection and adaptive management of currently known (and in some cases historic) sites. (USFWS, 2007)
- Provide evidence that the populations at these sites are stable or increasing over a number of years, which is determined by the life history of the individual species. (USFWS, 2007)

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists. (USFWS, 2007)
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. (USFWS, 2007)
- Seed is stored in Center for Plant Conservation cooperating facilities. (USFWS, 2007)
- Seed germination and propagation techniques are understood. (USFWS, 2007)
- Successful outplanting techniques are developed. (USFWS, 2007)
- Host plant and weed management plan are developed and implemented. (USFWS, 2007)
- Life history research is conducted that aids in the conservation and recovery of the species. (USFWS, 2007)
- Hybridization with Castilleja affinis is understood. (USFWS, 2007)
- If declining, determine the cause and reverse trend. (USFWS, 2007)
- Because the removal of cattle and the reduction in deer have had a positive effect on seedling recruitment, the program to eliminate ungulates from the island by 2011 should continue as planned. (USFWS, 2007)
- During the time that the special use permits are in effect, if targeted hunting of deer and elk is no longer effective, the NPS should consider other actions to reduce the threats of these animals to the species. (USFWS, 2007)
- Based on the reports produced by the Scientific Panel, indeterminate threats, in addition to ungulate herbivory, scraping and general presence are contributing to the decline in the amount of inflorescence and percentage cover of Castilleja mollis. Therefore, other parameters that influence the species' ability to recover should be tracked at both locations where the species is found. In particular, the following monitoring actions are recommended: (a) monitor community species composition and cover to indicate whether the habitat is improving; (b) monitor rate of hybridization with Castilleja affinis to understand the level of threat this poses on recovering the species; (c) monitor damage to inflorescence, stems, and leaves caused by insects; (d) monitor the number of plants, or seedlings and juveniles within the populations; and (e) monitor the rate of erosion using soil depth/amount of litter. (USFWS, 2007)
- The following downlisting measures outlined in the recovery plan should be implemented: (1) seed storage in a Center for Plant Conservation facility, and (2) development and implementation of host plant and weed management actions. (USFWS, 2007)
- To secure several populations of Castilleja mollis containing a minimum of 2,000 plants each, efforts should focus on restoring coastal goldenbush scrub habitat so that there is reduced fragmentation within populations of Castilleja mollis on the island. (USFWS, 2007)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue demographic monitoring of the two populations of C. mollis, and analyze longterm demographic and environmental monitoring data to determine trends. 2. Use morphological characters from the genetic study to define the geographic edges of the C. mollis populations. 3. Map the distribution of plants within the populations, including plants outside of the demography plots. 4. Augment current populations, especially Jaw Gulch, expand current populations, and establish new populations in areas above sea level rise effects. 5. Collect confirmed C. mollis seed from both populations for accession in conservation seed banks. 6. Ensure that visitor use does not impact C. mollis at the Jaw Gulch and Carrington populations (USFWS, 2023).

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# SPECIES ACCOUNT: *Castilleja ornata* (swale paintbrush)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered

**Physical Description**

Herbs, annual, 1.7–3.5(–5) dm; with a thin taproot or fibrous root system. Stems solitary or few to several, erect or ascending, often branched low on stem, unbranched distally, hairs appressed or retrorse, medium length, soft, eglandular, mixed with shorter stipitate-glandular ones. Leaves green or purple-tinged, proximal forming a rosette, linear-lanceolate to oblong or oblanceolate, 2–4 cm, not fleshy, clasping, margins wavy, sometimes plane, involute, 0-lobed, apex acuminate, acute, or obtuse. Inflorescences 3–24 × 1.5–3 cm; bracts proximally green, distally white, sometimes very pale yellow, often aging dull pink or dull redpurple, spatulate, 0-lobed, sometimes seeming lobed due to wavy margins, apex obtuse to rounded. Calyces green throughout or distal margin white aging pink, 15– 17 mm; abaxial and adaxial clefts 6–14 mm, 35–45% of calyx length, deeper than laterals, lateral 0(–0.7) mm, 0(–5)% of calyx length; lobes short-triangular, abaxial segments longer than adaxials, apex acute to obtuse or rounded. Corollas slightly curved, 22–24 mm; tube 10–13 mm; beak exserted, adaxially green, 5–10 mm; abaxial lip pale greenish, reduced, pouches 3, 0.5–1.5 mm, 5–10% as long as beak; teeth slightly incurved, reduced, pale greenish to white, 0.3–0.7 mm. 2n = 24 (Figure 2-1) (Egger et al., 2019, “Castilleja ornata”). Elevations of the known habitats for the species range from approximately 1,500–2,300 meters (m) (4,920–7,550 feet (ft)). Precipitation follows a bimodal pattern throughout the range, with approximately two-thirds of annual precipitation occurring during the summer monsoon period (June–August) and the remainder occurring primarily in winter (NatureServe 2021a, unpaginated). The historically documented range extent of C. ornata is approximately 587 kilometers (km) (365 miles (mi)). (USFWS, 2023).

**Taxonomy**

astilleja ornata is a member of the Orobanchaceae (broomrape) family. This is a family of parasitic plants, and the Castilleja genus is hemi-parasitic (Freeman et al. 2019, “Orobanchaceae”; Egger et al. 2019, “Castilleja”), meaning that Castilleja species can survive, but usually not thrive, without acquiring nutrients and/or other chemicals from the roots of host plants (Granados-Hernández et al. 2020, pp. 152–153). The genus Castilleja includes over 200 species (approximately 170 species are perennial) that occur in North America, Andean South America, Central America, and northern Asia (Tank et al. 2009, pp. 182–183, 186; Egger et al. 2019, entire). Within the genus, C. ornata belongs to a unique assemblage of Mexican Castilleja species, known as the Macrostigma group, which also includes C. sphaerostigma, C. macrostigma, C. angustata, and C. hidalgensis. Except for C. ornata, which also occurs in portions of the United States, each of the five species is endemic to different portions of central and northern Mexico and is unique in morphology, ecology, and distribution (Egger 2002, pp. 193, 195). The currently accepted classification is (Integrated Taxonomic Information System 2022, unpaginated): Domain: Eukaryota Kingdom: Plantae Division: Tracheophyta Class: Magnoliopsida Order: Lamiales Family: Orobanchaceae Genus: Castilleja Mutis ex L.f. Species: Castilleja ornata (Eastwood 1909) Common name: swale paintbrush, Glowing Indian paintbrush, or ornate paintbrush (USFWS, 2023)

**Historical Range**

The Swale Paintbrush was historically documented from 13 sites in the United States and Mexico, spanning a range extent of approximately 587 kilometers (km) (365 miles (mi)): 2 sites in the Animas Valley of Hidalgo County, New Mexico, and 11 sites in the eastern Sierra Madre Occidental of Chihuahua and northern Durango in Mexico. Currently, only one site—the Gray Ranch site in the Animas Valley of Hidalgo County, New Mexico—is known extant; the species was last observed at this site in 2021. The status of historically collected sites at the Cowan Ranch in New Mexico and in the eastern Sierra Madre Occidental of Mexico is unknown. The last observations of these historical sites were 1993 in New Mexico and 1985 in Mexico. (USFWS, 2024).

**Current Range**

Currently, only one site—the Gray Ranch site in the Animas Valley of Hidalgo County, New Mexico—is known extant; the species was last observed at this site in 2021. The status of historically collected sites at the Cowan Ranch in New Mexico and in the eastern Sierra Madre Occidental of Mexico is unknown. The last observations of these historical sites were 1993 in New Mexico and 1985 in Mexico. (USFWS, 2024).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Cross-pollination (Likely insect pollinated)

**Lifespan**

Adult: Annual plant

**Breeding Season**

Adult: Earliest flowering specimens are from late May to early June (USFWS, 2023)

**Other Reproductive Information**

Adult: Swale Paintbrush relies on cool season precipitation, monsoon precipitation, and a suitable surface/subsurface hydrology to complete its life cycle and maintain its seedbank. Thus, this species is sensitive to natural or artificial drought. Artificial drought may occur when upslope obstacles to, or diversions of, surface and near-surface flows starve downslope areas that would have otherwise received those flows (Raiter et al. 2018, pp. 445–446; Roth 2020, p. 5; Nichols and Degginger 2021, entire). (USFWS, 2024)

**Reproduction Narrative**

Adult: Since C. ornata is an annual plant and Castilleja seed longevity is not documented at greater than two years in the wild, frequent replenishment of seedbanks is essential to population persistence. Replenishment of viable seed requires flower production, ovule fertilization, ovule maturation, and seed dispersal. Flower production and ovule maturation require adequate growing conditions (see section 2.4.2 – Establishment and Growth), and ovule fertilization likely requires pollinators (Sun Kim et al. 2019, p. 11; Clark 2015, pp. 43–44; Kaye and Lawrence 2003, p. 11). Further, seed fitness—which increases with increased genetic diversity— requires population abundance in addition to pollinators for outcrossing (Clark 2015, p. 44; Paschke et al. 2002, pp. 1252, 1255–1257). Castilleja ornata's breeding system has not been studied. While the genus Castilleja includes both self-incompatible and self-compatible species, the majority of studied Castilleja taxa are mostly to entirely self-incompatible and reliant on insects and/or birds to transport pollen between genetically unique plants (Sun Kim et al. 2019, p. 11; Clark 2015, pp. 43–44; Kaye and Lawrence 2003, p. 11). While autogamous Castilleja species (species with flowers capable of fertilizing themselves) tend to be pale-bracted, not all pale-bracted species are autogamous; since C. ornata has an exserted stigma (a stigma physically separated from its anthers), it is likely also self-incompatible. Castilleja ornata's pollinators are unknown, and potential pollinators include bumblebees (Bombus spp.), sweat bees (family Halictidae), hummingbirds (family Trochilidae), and thrips (order Thysanoptera) (Duffield 1972, pp. 110–111; Clark 2015, pp. 27–28, 65). Hummingbirds are thought to primarily pollinate Castilleja species with red floral bracts, so insects are presumed to be the primary pollinators for Castilleja species with yellow floral bracts (Duffield 1972, pp. 110–111, 113). Wind pollination is unlikely because stamens are protected from wind by floral tubes. Successful reproduction is supported by healthy populations of local native pollinators. Pollinators, in turn, must be sustained by abundant, diverse, and reliable sources of native nectar and pollen plants (USFWS, 2023).

**Habitat Type**

Adult: Grasslands (USFWS, 2023)

**Environmental Specificity**

Adult: Elevations of the known habitats for the species range from approximately 1,500–2,300 meters (m) (4,920–7,550 feet (ft)) (USFWS, 2023).

**Habitat Narrative**

Adult: Castilleja ornata is native to grassland ecosystems (plains and great basin grassland biotic communities) of southwest New Mexico in the United States and of the eastern Sierra Madre Occidental of Chihuahua and Durango in Mexico (Figure 2-2; McIntosh 1994, p. 329; Brown 1994, pp. 115–121). Elevations of the known habitats for the species range from approximately 1,500–2,300 meters (m) (4,920–7,550 feet (ft)). Precipitation follows a bimodal pattern throughout the range, with approximately two-thirds of annual precipitation occurring during the summer monsoon period (June–August) and the remainder occurring primarily in winter (NatureServe 2021a, unpaginated). The historically documented range extent of C. ornata is approximately 587 kilometers (km) (365 miles (mi)). (USFWS, 2023)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Information about seed dispersal for C. ornata is incomplete. Most seeds are likely shaken from seed capsules by wind and settle to the ground within a short distance of the parent plant (Godt et al. 2005, p. 88). The seeds are light (averaging 0.052 milligrams [mg] per seed, or 19,200 seeds per gram) and could possibly be dispersed short to moderate distances by wind (Service 2021, unpaginated). Additionally, insects and small mammals likely contribute to local seed dispersal (Kolar and Fessler 2006, in litt.). While rare, long-distance dispersal events are also possible for Castilleja species (Tank and Olmstead 2009, p. 1917), natural colonization of new sites likely primarily occurs as the result of a series of short dispersals over time (USFWS, 2023)

***Population Information and Trends***

**Resiliency:**

low resiliency (USFWS, 2023)

**Representation:**

Limited representation (USFWS, 2023)

**Redundancy:**

Lack of redundancy (USFWS, 2023)

**Number of Populations:**

1 Extant (USFWS, 2024)

**Population Narrative:**

Currently, only one site—the Gray Ranch site in the Animas Valley of Hidalgo County, New Mexico—is known extant; the species was last observed at this site in 2021. The status of historically collected sites at the Cowan Ranch in New Mexico and in the eastern Sierra Madre Occidental of Mexico is unknown. The last observations of these historical sites were 1993 in New Mexico and 1985 in Mexico (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Altered fire regime (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Habitat loss and fragmentation (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Hydrological alteration (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Intensive grazing pressure (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:**

**Stressor:** Exotic plant invasion (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

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

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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**References**

USFWS. 2023. Species status assessment report for the swale paintbrush (glowing Indian paintbrush) (Castilleja ornata): Version 1.1. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico. USFWS. 2024. Recovery Outline for the Swale Paintbrush (Castilleja ornata). USFWS. Southwest Region. New Mexico Ecological Services Field Office. Albuquerque, NM. 19 pp.

USFWS. 2023. Species status assessment report for the swale paintbrush (glowing Indian paintbrush) (Castilleja ornata): Version 1.1. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico.

# SPECIES ACCOUNT: *Caulanthus californicus* (California jewelflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/19/1990; California/Nevada Region (R8) (USFWS, 2015)

**Physical Description**

Caulanthus californicus is a glabrous decumbent to erect often branched annual, with whitish petals and spherical seeds. Leaves are less than 11 millimeters (mm) (0.4 inch (in.)) in length and are shallowly cut to wavy-dentate and tapered. Calyx petals (outer whorl) are generally spreading, 4–10 mm (0.15–0.4 in.) in length, maroon, keeled, and darker in bud stage. Corolla petals (inner whorl) are 6–11 mm (0.2–0.4 in.) long and whitish, with wavy margins (Buck 1993). (USFWS, 2013)

**Taxonomy**

USFWS tracks as synonym 01 - Caulanthus Californicus (8/93). (NatureServe, 2015)

**Historical Range**

Originally in San Joaquin and adjacent valleys. Once fairly abundant in appropriate habitat in Fresno, Kern, King, Santa Barbara, San Luis Obispo and Tulare counties. (NatureServe, 2015)

**Current Range**

Appears to be currently extant in Fresno, Kings, Kern, and Santa Barbara Counties (CalFlora Occurrence Database website Feb. 2, 2000). Extirpated from Kings County, but present in San Luis Obispo County (CNPS Inventory, 2001). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 1998)

**Habitat Narrative**

Adult: Extant populations of California jewelflower occur in Nonnative Grassland, Upper Sonoran Subshrub Scrub, and Cismontane Juniper Woodland and Scrub(E. Cypher unpubl. data). Historical records suggest that California jewelfiower also occurred in the Valley' Saltbush Scrub community in the past (CDFG 1995).  Herbaceous cover was dense at most California jewelfiower sites studied in 1993 (Cypher 1994a). Native plant species, such as annual fescue (Vulpia microstachys), clovers (Trifolium spp.), red maids (Calandrinia ciliata), and goldfields (Lasthenia californica) comprised a high proportion of the vegetation at many' of the known locations over several years. The exotic grass red brome (Bromus madritensis ssp. rubens) was a significant component of the vegetation only at the Carrizo Plain sites (Taylor and Davilla 1986, Lewis in litt. 1993, Cypher 1994a, E. Cypher unpubl. data). On the Carrizo Plain. California jewelfiower occurred primarily on the burrow systems of giant kangaroo rats (Dipodamvs ingens), another endangered species (Cypher 1994a). Populations of California jewelflower have been reported from elevations of approximately 75 to 900 meters (240 to 2,950 feet) and from level terrain to 25 percent slopes. Soils at known sites are primarily subalkaline, sandy loams (CDFG 1995, Taylor and Davilla 1986, Lewis in litI. 1993) (USFWS, 1998).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**
Decline (NatureServe, 2015)

**Population Growth Rate:**
Slowly declining (NatureServe, 2015)

**Number of Populations:**
37 (USFWS, 2020)

**Population Narrative:**
At the time of listing (1990), California jewelflower was known from three localized areas: the mouth of Santa Barbara Canyon in Santa Barbara County, the southern portion of the Carrizo Plain in San Luis Obispo County, and the Paul Paine Preserve (owned by The Nature Conservancy) in Kern County (Service 1990). At the time of our 2013 status review, there were 34 presumed extant occurrences: one introduced occurrence in Kern County; 7 occurrences in Santa Barbara County; 22 occurrences in San Luis Obispo County; 3 occurrences in Fresno County; and 1 occurrence in Kings County. A summary of past and current distribution can be found in Table 1 below. Four occurrences (numbers 81, 82, 83, and 84) have been added to the Diversity Database since our 2013 review (Diversity Database 2020). All four of these occurrences are in Kern County and do not extend the range of the species. The status of the one remaining extant occurrence in Kings County (occurrence number 5) has been changed to “possibly extirpated” since our last review. Table 1 in Appendix A summarizes the number of occurrences over time. Currently, there are 37 Diversity Database occurrences that are presumed extant. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Urbanization (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing the primary threats to C. californicus were the ongoing and threatened destruction and adverse modification of habitat due to agricultural land conversion and urbanization on the San Joaquin Valley floor (Service 1990). Non-urbanized or non-converted lands, which largely occurred in the neighboring foothills and valleys, were subject to livestock grazing, oil and gas exploration and development, off-road vehicle use, and mining (Service 1990). (USFWS, 2013)

**Stressor:** Agriculture (USFWS, 2013)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The CVP supplies water to more than 250 long-term water contractors in the Central Valley, Santa Clara Valley, and eastern San Francisco Bay Area. Agricultural conversions and related operations either directly or indirectly facilitated by the CVP include: conversion of native habitats to agricultural fields; conversion of land use to more water intensive purposes; disposal of agricultural drain water; application of pesticides; and other mowing and harvesting operations. Agricultural conversion and related operations have contributed to the loss and degradation of several habitat types, including grasslands and alkali scrub associated with declines of multiple listed species (Service 1998). (USFWS, 2013)

**Stressor:** Mining (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mining presented a threat to C. californicus (Service 1990). On the Carrizo Plain National Monument (Monument), only valid leases, claims and other rights that existed as of the date of the Proclamation, January 17, 2001, may see mineral development on federal lands within the Monument (BLM 2010). (USFWS, 2013)

**Stressor:** Oil and Gas Exploration and Development (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, oil and gas exploration and development presented a threat to C. californicus (Service 1990). Adverse effects of oil and gas development on C. californicus include the loss of habitat, changes in habitat quality, destruction of individuals or populations and their seed bank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. (USFWS, 2013)

**Stressor:** Off-road Vehicle Use (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, off-road vehicle use presented a threat to C. californicus (Service 1990). Off road vehicle use has been reported as a minor threat potentially affecting 7 occurrences on the Carrizo Plain National Monument where no off-road motorized or mechanized travel is legally permitted (BLM 2010). (USFWS, 2013)

**Stressor:** Solar Power Development (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, solar power development did not present a threat to C. californicus. Solar power development projects pose potential threats to and may impact large amounts of habitat. These projects can destroy, fragment, or impact C. californicus habitat by: altering landscape topography, vegetation, and drainage patterns; and reducing habitat quality

through interception of solar energy normally reaching the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (Smith 1984; Smith et al. 1987 as cited in J.R. Single 2010). Moreover, recently proposed solar projects tend to be large contiguous blocks of disturbance in undeveloped habitat lands, ranging from hundreds to several thousand acres. (USFWS, 2013)

**Stressor:** Predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, domestic livestock predation was thought to have extirpated colonies of C. californicus (Service 1990). On the Carrizo Plain, C. californicus is known to occur within and around the precincts or burrows of the endangered giant kangaroo rat (Dipodomys ingens). Giant kangaroo rats apparently seek out C. californicus, because stems of this species were clipped with equal frequency both on precincts (circular areas with a concentration of giant kangaroo rat burrows) and in interspaces of giant kangaroo rat burrows; however, directed research exploring interactions of plant and animal species in the community should be completed (Cypher 1994). (USFWS, 2013)

**Stressor:** Grazing (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Domestic livestock grazing has been used to reduce grass and forb competitors in endangered plant habitats; however, the use of domestic livestock grazing to benefit native plant species has had mixed results (Vesk and Westoby 2001; Floyd et al. 2003; Kimball and Schiffman 2003). Direct effects from cattle grazing are reported to be detrimental because cattle seek out and show preference for eating the plant (Service 1998). The habitat of C. californicus in Fresno County is grazed after the dispersal of its seeds in late spring and prior to the new growth of its basal rosettes in late winter. (USFWS, 2013)

**Stressor:** Competition from Nonnative Grasses (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The southern San Joaquin Valley of California, as with much of western North America, has been invaded by nonnative plant species during the past 100 to 200 years. These include the following species: Bromus rubens (red brome), Vulpia myuros (mouse tail fescue), Schismus arabicus (Arabian grass), Hordeum murinum ssp. glaucum (known locally as foxtail and elsewhere as smooth barley), Bromus diandrus (ripgut brome), and Bromus hordeaceus (soft chess) (Biswell 1956; Germano et al. 2001). Individual invasive species could modify ecosystem properties (Gordon 1998). (USFWS, 2013)

**Stressor:** Competition from Nonnative Plant Species Due to Fire Retardant Application (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Another threat to California jewelflower is invasion and competition from nonnative plant species; this threat could be exacerbated by the application of fire retardant, which can act as a nutrient source for nonnative invasives. California jewelflower habitat includes slightly alkaline sandy loams; the low nitrogen levels of these soil conditions are unfavorable for nonnative, which in turn provides a competitive advantage to species, such as the jewelflower, which have adapted to the nutrient-poor environment. Nitrogen and phosphorus could be increased in the soil through the application of ammonium-based retardants. (USFWS, 2013)

**Stressor:** Nitrogen Deposition (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nitrification of soil was not considered a threat at the time of listing C. californicus, but should currently be considered a threat. There is little information regarding C. californicus and soil nitrogen levels in which it occurs (B. Delgado, BLM pers. comm. 2011), however some adverse soil conditions (low nutrients, low water holding capacity) exert stress on plant species and can reduce competition, particularly for species that are not tolerant of the soil stress factors (R. O'Dell pers. comm. 2011). Human activities have increased nitrogen availability throughout terrestrial systems (Suding et al. 2005). Three major producers of nitrogen emissions are transportation, agricultural production, and industrial activities including electricity production (Spiegel 2003). (USFWS, 2013)

**Stressor:** Pollinators (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, the declines in the pollinators of all descriptions were not considered a threat to C. californicus. Since that time, the reduction to the population of the non-native honeybee (Apis mellifera), often referred to as colony collapse disorder, has been well documented. Native insects may pollinate the C. californicus, however a reduction in their abundance has been observed as well (United States 2007). (USFWS, 2013)

**Stressor:** Genetic Diversity (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss of genetic diversity was not considered a threat at the time of listing C. californicus. However, considering the reduction of the range of the C. californicus and fragmentation of habitat, lack of cross pollination between populations of the remaining localities may be a future threat. This may result in the loss of genetic diversity, which may reduce the adaptability of the plant to current and future environmental conditions and also increases the threat of inbreeding depression. Loss of genetic diversity and adaptability is likely to reduce the long-term survival of plant species (Huenneke 1991). (USFWS, 2013)

**Stressor:** Climate Change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Climate change was not considered a threat to C. californicus at the time of listing; however, climate change is a potential threat to the species. Projected California temperature rise estimates range from an increase of 1.7° Celcius to 5.8° Celcius (3.0° Fahrenheit to 10.4°Farhenheit) for years 2000 - 2100 (Cayan et al. 2006). Climate change has the potential to alter the timing and synchronicity of ecosystem processes. The interactions between flower production and insect availability for pollination may be altered (Field et al. 1999; Cayan et al. 2006). Changes in temperature and precipitation likely will alter the structure, composition, and productivity of vegetation communities and wildfire may become more frequent and intense (Lenihan et al. 2006). (USFWS, 2013)

***Recovery***

**Reclassification Criteria:**
1. Secure and protect specified recovery areas from incompatible uses on ninety-five percent of occupied habitat on public lands; 75 percent of population and occupied habitat in Santa Barbara Canyon. (USFWS, 2013)

2. Management Plan approved and implemented for recovery areas that include survival of the species as an objective for all protected areas identified as important to continued survival. (USFWS, 2013)

3. Population monitoring for specified recovery areas shows that the populations are stable or increasing through the normal precipitation cycle. (USFWS, 2013)

**Delisting Criteria:**
Delisting criteria is not available.

**Recovery Actions:**
- Surveys will be necessary to determine whether natural populations remain in all target areas. (USFWS, 1998)
- Unoccupied habitat within metapopulations also should be protected to facilitate movement of pollinators and seed dispersers. (USFWS, 1998)
- The top-priority action for recovery of California jewelflower is to protect the plants on private land in Santa Barbara Canyon. (USFWS, 1998)
- Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion. (USFWS, 1998)
- Additional tasks are required to achieve recovery goals. These tasks include developing management plans, surveying for additional populations, banking seed, conducting research, and modeling population demographics using matrix projection modeling. (USFWS, 1998)
- Protection of extant populations and reintroductions as described in the 1998 Recovery Plan should be completed. Management on public lands should include provisions for suitable levels of sheep and cattle grazing. Protection of colonies on private lands or those to be re-established on private lands could result from partnering with landowners or offering conservation easements. (USFWS, 2013)
- Regular yearly surveys utilizing a standardized methodology should be conducted over the next five years at the Santa Barbara Canyon area in the Cuyama Valley in Santa Barbara

County, at the Carrizo Plain National Monument in San Luis Obispo County, and at the Kreyenhagen Hills in Fresno County so that the determination of what constitutes a sustainable population can be defined and environmental variables affecting abundance, such as precipitation and temperature, can be monitored. (USFWS, 2013)
- Successful re-establishment of populations will require an adequate understanding of the biology of the species and a robust seed collection. Studies should be conducted that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful re-establishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. Seeds should be collected from each of the three sites and banked at an appropriate depository. (USFWS, 2013)
- Threats such as loss and degradation of habitat should be eliminated, reduced, or ameliorated. The potential for habitat degradation due to nitrogen deposition and threats to pollinators from regional pesticide use should be analyzed and appropriate measures to ameliorate these threats should be implemented. (USFWS, 2013)

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2013 5-year review (Service 2013), scientific literature, and as a result of discussions with species experts. 1. Protect existing habitat in the San Joaquin Valley for the California jewelflower. 2. A comprehensive evaluation should be completed for all known occurrences (both extant and extirpated). The site-specific evaluation should include, at minimum, whether the species is present, the estimated population/occurrence size, and an in-depth analysis of threats at that location. 3. Implement and/or continue yearly surveys utilizing a standardized methodology to determine trends in the range-wide status of the species as well as population/occurrence abundance. 4. Conduct studies that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful reestablishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. 5. Analyze the potential for habitat degradation due to climate change and nitrogen deposition, as well as threats to pollinators from regional pesticide use. Appropriate measures to ameliorate these threats should be implemented. (USFWS, 2020)

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# SPECIES ACCOUNT: *Ceanothus ferrisae* (Coyote ceanothus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 02/03/1995; California/Nevada Region (R8) (USFWS, 2015)

**Physical Description**

An evergreen shrub, 1-2 m tall. Leaves are < 3.2 cm long, rounded, tapering towards the base. The leaves are opposite and round with a dark green, hairless upper surface and a lighter green undersurface with minute hairs (Schmidt 1993). Leaf margins have short teeth or sometimes lack teeth; the leaf base is abruptly tapering or rounded. Small white flowers are borne in clusters 1.3 to 2.5 centimeters (0.5 to 1.0 inch) in length (McMinn 1933; Schmidt 1993). (NatureServe, 2015; USFWS, 2011)

**Taxonomy**

USFWS and CAHP tracks as synonym 01 - Ceanthous ferrisiae (9/93). (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

At the time of listing and our 2011 5-year review, coyote ceanothus was only known from three locations in Santa Clara County, all within 6 km (4 miles) of each other (Service 1995, p. 6675; Service 2011). The current species distribution is similar to what was previously described, with three extant populations (Anderson, Llagas Road, and Kirby) distributed within an approximately 3-mile radius of Anderson Reservoir near the City of Morgan Hill (Vasey 2013, p. 1; CDFW 2021; Valley Water 2021, p. 4). The Kirby population and Anderson population are located on the eastern side of the Santa Clara Valley while the Llagas Road population occurs on the western side of the Santa Clara Valley. The 2011 5-year review further divided the Anderson population into two small subpopulations and one large population that are fragmented by Anderson Dam (Service 2011, p. 7). However, a genetic analysis conducted on all three extant populations did not support the dividing of the Anderson population into subpopulations (see Genetics subsection in the Coyote Ceanothus Population Creation Pilot Study section) (J. Hillman, Valley Water, in litt. 2013, p. 3; J. Hillman, Valley Water, in litt. 2021d; Potter 2012, p. 3; Honeycutt 2012, p. 5). There is an estimated 482 acres of occupied coyote ceanothus habitat range-wide: 400 acres in the Anderson population, 75 acres in the Llagas Road population, and 7 acres in the Kirby population (USFWS, 2023).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2011)

**Lifespan**

Adult: 20 to 50 years (USFWS, 2011)

**Breeding Season**

Adult: January to March (USFWS, 2011

**Key Resources Needed for Breeding**

Adult: Possibly fire; require multiple, large populations within close proximity to allow genetic migration to occur via pollination (USFWS, 2011)

**Reproduction Narrative**

Adult: Ceanothus ferrisae is a perennial, flowering from January to May (Munz and Keck 1959). Ceanothus reach reproductive maturity after 5- 6 years. Will hybridize with other species or sub-species in situations where only one plant exists or there is genetic incompatibility with surrounding plants of the same species. (USFWS, 2011). The role of fire in the ecology of this plant remains unclear. Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks. C. ferrisae require multiple, large populations within close proximity to allow genetic migration to occur via pollination. The average lifespan for this species is estimated to range from 20 to 50 years (Keeley 1975; T. Parker, pers. comm., 2010; D. Wilken, pers. comm., 2010). (USFWS, 2011)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Barrens, Shrubland/chaparral (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Possibly fire (USFWS, 2011)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations < 300 m (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Colonial (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from USFWS, 2011)

**Dependency on Other Individuals or Species for Habitat**

Adult: Rare species associated with Ceanothus ferrisae include the federally listed bay checkerspot butterfly (Euphydryas editha bayensis), Santa Clara Valley dudleya (Dudleya setchellii), and most beautiful jewelflower (Streptanthus albidus ssp. peramoenus) (Evens and San 2004). It is also associated with bigberry manzanita (Arctostaphylos glauca), California coffee berry (Rhamnus californica), California sagebrush (Artemesia californica), common yarrow (Achillea millefolium), foothill pine (Pinus sabiniana), leather oak (Quercus durata), and toyon (Heteromeles arbutifolia) (Corelli 1991; Evens and San 2004). Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks. (USFWS, 2011)

**Habitat Narrative**

Adult: Ceanothus ferrisae grows on arid slopes in mixed serpentine chaparral, valley, and foothill serpentine bunchgrass grasslands below 300 meters (about 1,000 feet) (Munz and Keck 1959; Hickman 1993). C. ferrisae is found in colonies at the Llagas Road location (CNDDB, 2010). Rare species associated with C. ferrisae include the federally listed bay checkerspot butterfly (Euphydryas editha bayensis), Santa Clara Valley dudleya (Dudleya setchellii), and most beautiful jewelflower (Streptanthus albidus ssp. peramoenus) (Evens and San 2004). It is also associated with bigberry manzanita (Arctostaphylos glauca), California coffee berry (Rhamnus californica), California sagebrush (Artemesia californica), common yarrow (Achillea millefolium), foothill pine (Pinus sabiniana), leather oak (Quercus durata), and toyon (Heteromeles arbutifolia) (Corelli 1991; Evens and San 2004). (USFWS, 2011)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2011)

**Number of Populations:**

4 (USFWS, 2011)

**Population Size:**

>188,000 (USFWS, 2023)

**Minimum Viable Population Size:**

5000 (USFWS, 2011)

**Adaptability:**

Low (inferred from USFWS, 2011)

**Population Narrative:**

Two of the four existing occurrences of Ceanothus ferrisae have population sizes greater than 2,000 individuals (3,600 and > 100,000, respectively). Information available to the Service suggests a minimum population size of 5,000 may be necessary to maintain 95 percent fitness for plants (Reed 2005). A genetic Allee effect may occurring as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). The survival and recovery of existing C. ferrisae populations may be threatened by limited genetic diversity as a result of small or declining population size, habitat loss and fragmentation, and geographic isolation that may limit insect-mediated gene flow. (USFWS, 2011). At the time of listing fewer than 6,000 coyote ceanothus plants were known to exist, with the largest population (Anderson) estimated at approximately 5,000 plants (Service 1995, p. 6675). The 2011 5-year review estimated the Anderson population consisted of over >100,000 plants, the Kirby population at

150 plants, and the Llagas Road population at 600 to 650 plants (CDFW 2021; Service 2011, pp. 7–8) (Table 1). A 2011 survey of the Llagas Road population estimated the size at 1,000–2,000 plants (Table 1) (CDFW 2021). No additional surveys have been conducted to estimate the size of three populations of coyote ceanothus (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Destruction and modification of habitat, and development on recreational and private lands continues to be a threat for Ceanothus ferrisae. Construction of a commercial landfill at Kirby Canyon beginning in 1986 (prior to the listing of C. ferrisae in 1995) may have resulted in the undocumented loss of thousands plants, as evidenced by the decline of this population from 5,000 in 1987 to about 100 individuals observed in 1992 (Freas, pers. comm. 1993; LSA Associates 1992). The remaining population is currently threatened by altered fire regime and lack of recruitment. Proximity to the commercial landfill and urban development may limit or prevent the use of fire for regeneration. The Llagas Road population exists on private land that is nearly surrounded by residential development. Future development could result in increased encroachment upon existing habitat necessary for expansion of the Llagas Road population to meet recovery goals. The proximity of urban development may limit or prevent the use of fire to regenerate this population as well. (USFWS, 2011)

**Stressor:** Cattle grazing (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cattle have been grazing on the property for many years and may be negatively affecting the habitat and limiting recruitment for the Llagas Road population. The unprotected portion of the property where cattle grazing is permitted is nearly denuded of native chaparral vegetation with large areas of exposed soil and serpentine rocks evident (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). The cattle have gained access into the existing conservation easement through broken fencing thereby allowing them to browse on inflorescences of young C. ferrisiae plants before seed production can occur (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Heavy browsing by cattle and wild ungulates was observed among young, reproductive-age, plants during the fall 2010 survey at all sites (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman pers. comm., 2010). (USFWS, 2011)

**Stressor:** Dam activities (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The population located at Anderson Dam is threatened by loss and modification of habitat as a result of activities associated with the dam, actions to protect against damage from potential seismic activity, and un-regulated land management practices. Anderson Dam was constructed upon unstable materials and is positioned on a seismically active fault line (SCVHP

2010). (USFWS, 2011)

**Stressor:** Predation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Several insect species have been noted to infest Ceanothus species in California and predation in the form of herbivory by native ungulates and seed consumption by small mammals, insects, and birds is common (Deveny and Fox 2006). The western tent caterpillar (Malacosoma californicum) is known to construct large web-like tents on the branches of Ceanothus species (USDA 2006). Larvae feed on the leaves within the tent, often defoliating entire branches (USDA 2006). The western tussock moth (Orgyia vetusta) has been reported on Ceanothus species (USDA 2006). Large masses of cocoons may be observed on branches in late spring. Western tussock moth larvae feed on leaves and young growth, sometimes causing substantial defoliation and branch dieback. The western sycamore borer (Synanthedon resplendens) may attack Ceanothus species (USDA 2006). Adults emerge in May through early August and lay eggs within cracks, depressions, and injured tissues in the bark of old or slow-growing plants (USDA 2006). After hatching, larvae tunnel into the inner bark, creating winding tunnels that extend over 100 square centimeters (about 15.5 square inches). The amount of Herbivory may retard plant growth, destroy plants, and often reduces seed production (Boyd 2003; Deveny and Fox 2006). Black-tailed deer (Odocoileus hemionus columbianus) are primary browsers of C. ferrisae (Deveny and Fox 2006). Herds of black-tailed deer make their home in the Anderson Dam area. Evidence of browsing on fresh shoots, inflorescences, and leaves of young C. ferrisae plants was observed among all populations surveyed in mid-July and fall 2010 (F. Gardipee, pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Damage caused by western sycamore borers is generally considered to be insignificant (USDA 2006). (USFWS, 2011)

**Stressor:** Genetic Allee effect (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A genetic Allee effect may occur as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). Habitat loss and fragmentation, small population size, and genetic isolation may increase the risk of a genetic Allee effect for self-incompatible species, such as Ceanothus ferrisae, and ultimately result in a subsequent loss of long-term population viability (Willi et al. 2005; Berec et al. 2006: Leimu et al 2006; Honnay and Jacquemyn 2007; Wagenius et al. 2007; Pickup and Young 2008). The subdivision of this population has resulted in possible isolation and reduced connectivity, thus increasing the risk of genetic Allee effects and decreased population viability. (USFWS, 2011)

**Stressor:** Fire management (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The proximity of Ceanothus ferrisae to residential development may preclude or limit the use of fire that may be necessary for stand regeneration. Further research regarding the role of fire for C. ferrisae is warranted to insure effective use of this management tool can be applied

to benefit the long-term conservation of this species. (USFWS, 2011)

**Stressor:** Global climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, altered fire regimes, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. However, climate change may exacerbate the effects of altered fire regimes on population viability of Ceanothus species endemic to California (Lawson et al. 2010). (USFWS, 2011)

**Stressor:** Fungal Pathogens (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As mentioned previously, diseases were not considered a threat to the coyote ceanothus at the time of listing or the 2011 5-year review (Service 1995; Service 2011, p. 12). However, Fusarium oxysporum, a widespread taxa of fungus with both pathogenic and non-pathogenic strains, was identified as a potential weak root pathogen of nursery-grown coyote ceanothus as was observed during a wound inoculation test on terminal shoots for the coyote ceanothus population creation pilot study (Table 1) (Valley Water 2021, pp. 21–22). Although Fusarium proliferatum, another common fungal pathogen, was detected on the roots of coyote ceanothus that died at the introduction site along Coyote Ridge in the summer 2020 (Table 1), this taxa was not thought to be the cause of the die off based on the low virulence observed in a wound inoculation test on terminal shoots for the coyote ceanothus (Valley Water 2021, pp. 21–22). There is not sufficient data available to determine whether F. oxysporum or F. proliferatum is a threat to the health of coyote ceanothus in the wild (Valley Water 2021, p. 22). Botrytis, a common fungal pathogen that can be a problem under cool and moist conditions, was detected on coyote ceanothus container plants prior to outplanting at the introduction site on Coyote Ridge in late 2017 (Table 1); these infected seedlings exhibited leaf necrosis and wilted shoot tips (Valley Water 2021, p. 22). There is not sufficient data available to determine whether Botrytisis a threat to the health of coyote ceanothus in the wild; however, Valley Water is implementing measures to reduce the risk of spread (USFWS, 2023).

**Stressor:** Fire (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, fire was not considered to play an important role in the ecology of the coyote ceanothus and was considered a potential threat to the persistence of the species (Service 1995). However, the Recovery Plan and the 2011 5-year review identified an altered fire regime as a threat to the coyote ceanothus and reported the lack of natural recruitment without fire (Service 1998, pp. II-36, II-38, and II-39; Service 2011, pp. 17–18). An altered fire regime due to fire suppression continues to be a significant threat to the coyote ceanothus and a lack of fire is considered one of the biggest threats to the Llagas Road population (J. Hillman, Valley Water, in litt. 2021f). Valley Water observed the senescence of larger coyote ceanothus shrubs with a lot

of old, woody growth and dead branches on many of the larger plants in the Llagas Road population and recommended prescribed burning to remove dead wood and grass thatch, and promote the recruitment of new plants (J. Hillman, Valley Water, in litt. 2021f). Germination experiments at Stanford University demonstrated that under the right conditions coyote ceanothus can germinate without fire, but recruitment is less frequent and less abundant without fire (Service in litt. 2020a; J. Hillman, Valley Water, in litt. 2021c; Service 1998, p. II-36). As stated previously, there has been some natural recruitment of coyote ceanothus observed in the absence of fire above a perennial stream in the Kirby population, commonly along the exposed areas of the reservoir shoreline in the Anderson population, and many times over the years in the Llagas Road population (Valley Water 2021, pp. 29–30; J. Hillman, Valley Water, in litt. 2021d). In addition to a lack of fire, the species could also be threatened if fires occurred too frequently and increasing summer aridity is predicted to increase wildfire frequency and severity in the San Francisco Bay Area (see the Climate Change section below) (Williams et al. 2019, p. 892; Westerling 2018; Ackerly et al. 2018, p. 30, Figure 10). Additionally, the accumulation of biomass from invasive grasses in coyote ceanothus habitat facilitated by atmospheric N deposition increases the frequency and severity of wildfires (Rao et al. 2010 cited in Fenn et al. 2010, p. 2409; S. Weiss, Creekside Science Center for Earth Observation, in litt. 2021) (USFWS, 2023).

**Stressor:** Climate Change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of the 2011 5-year review, climate change was identified as a potential threat to the coyote ceanothus, but due to the uncertainty in predictions of climatic conditions for smaller subregions such as California, the Service lacked adequate information to make accurate predictions regarding its effects on the coyote ceanothus (Service 2011, p. 18). There is consensus that the increase in greenhouse gas emissions during the 20th century resulted in global climate change characterized by: warming atmospheric and ocean temperatures, diminishing snow and ice, and rising sea levels (Intergovernmental Panel on Climate Change 2014, pp. 2–3). While the influence of climate change on these highly localized features of the San Francisco Bay Area climate is poorly understood at this time, there is general agreement about increasing temperatures and increasing interannual variability of precipitation (Ackerly et al. 2018, pp. 6, 13). Further, warming near the San Francisco Bay Area coast will be affected by changes in fog and sea breeze (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
1. Protection and management of the four known occurrences of Ceanothus ferrisae by working with Santa Clara County, the SCVWD, and private landowners to ensure long-term survival of the species on their lands. (USFWS, 2011)

2. Survey of other potential serpentine habitats to identify potential habitat. (USFWS, 2011)

3. Seed collection and research. Collection and banking of seed in Center for Plant Conservation certified botanic gardens is prudent to guard against extinction of the species from catastrophic events and to provide potential material for enhancement efforts in existing populations,

repatriations, and/or introductions to new sites. All known populations should be represented in seed collections. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 2011)

4. Research on demography, fire ecology, and effects of grazing. Important research questions include how grazing impacts the reproduction, recruitment, and survival of the species, and why so little recruitment is observed in natural populations. (USFWS, 2011)

5. Establishment of new populations to meet recovery goal of eight populations representing the entire historic range. Ceanothus ferrisae should not be considered for delisting unless eight populations, consisting of at least, 2,000 individuals, within its historic range and representing its entire historic range. (USFWS, 2011)

Recovery Priority Number: 14

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Recovery actions are not available.
- Habitat conservation to support the survival and recovery of Ceanothus ferrisae should be accomplished through land acquisition and establishment of conservation easements where possible. Protection of C. ferrisae populations on private lands through additional conservation easements and land purchases, and restoration of additional populations within the historic range should be prioritized to minimize the likelihood of extinction. (USFWS, 2011)
- Research that will inform management decisions, conservation planning, and restoration efforts for Ceanothus ferrisae should be conducted. (USFWS, 2011)
- Establishment of additional Ceanothus ferrisae populations where appropriate serpentine chaparral habitat has been identified in the proposed SCVHP. Restoration efforts should target habitat sites that can support a minimum population of at least 5,000 individuals. (USFWS, 2011)
- Enhancement and regeneration of existing populations of Ceanothus ferrisae to achieve minimum populations of 5,000 plants through various strategies. For example, implementation of an optimal fire regime (determined through research) to stimulate seedling production from the soil seed bank may prove to be a successful strategy to increase small population sizes. Fire applied to small areas over several years may yield large, sustainable populations, consisting of a mosaic of age classes and genotypes, which may be less vulnerable to stochastic events and senescence. Translocation efforts may prove successful as well. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation, restoration, and Phytophthora avoidance recommendations that will aid in the recovery and conservation of the coyote ceanothus. 1. Research should further analyze the cause of the decline of the Kirby population. A restoration effort including the introduction of new genotypes should be conducted for the Kirby population since it has the lowest genetic diversity and shows evidence of

inbreeding (Honeycutt 2012; J. Hillman, Valley Water, in litt. 2013). 2. Public access should be restricted and trails rerouted away from all coyote ceanothus populations in order to prevent the introduction and spread of the plant pathogen Phytophthora. Specifically, public access should be prohibited near the Kirby population due to the detection of Phytophthora in a stream downhill from the Kirby population near the public entry point. 3. All work within or near coyote ceanothus habitat should follow the best management practices and updated guidance provided by the Working Group for Phytophthoras in Native Habitats available at https://www.suddenoakdeath.org/welcome-to-calphytos-orgphytophthoras-in-native-habitats/(e.g., Working Group for Phytophthoras in Native Habitat 2016). Any revegetation efforts within coyote ceanothus habitat should use only direct seeding instead of installing container plants unless the nursery can prove that the container plants are free of Phytophthora and all necessary best management practices are being implemented at the nursery to prevent the introduction and spread of Phytophthora consistent with the “Guidelines to Minimize Phytophthora Pathogens in Restoration Nurseries” (https://www.suddenoakdeath.org/wpcontent/uploads/2020/08/Restoration.Nsy_.Guidelines.final_.092216_rv_8.20.20.pdf, Working Group for Phytophthoras in Native Habitat 2020). 4. Efforts should continue to preserve the Anderson and Kirby populations of the coyote ceanothus with a minimum 1,000-foot buffer around the occurrences. 5. Any additional introduction or population creation efforts for coyote ceanothus should occur on the western side of Santa Clara Valley near the Llagas Road population, where the climate is more mesic and population genetic diversity is highest.The created population should be planted annually over a series of years from seed collected regularly from the Llagas Road population in order to mimic natural recruitment and allow the establishment of multiple age classes.Both direct seeding and installation of container plants following strict phytosanitary measures should be used for the population creation. 6. Coyote ceanothus seedlings and young plants should be caged in wide cages in the Llagas Road population to reduce browse/herbivory and set up wildlife cameras in extant occurrences of the coyote ceanothus to examine browse pressure and herbivory. A study should also be conducted comparing the abundance of rodents and rates of seed predation under browsed and unbrowsed coyote ceanothus. Vegetation cover (e.g., non-native grasses, sagebrush) near coyote ceanothus should be reduced if it is determined that the vegetation supports a high abundance of rodents that prey on the seeds and seedlings. 7. The Llagas Road population should be tested for the presence of Phytophthora pathogens. 8. Prescribed burning should be investigated as a management tool for regeneration in the Llagas Road population because it facilitates the removal of dead wood and grass thatch and promotes natural recruitment. 9. Research should further explore the soil microsymbiotic relationships such as Frankia and mycorrhizae in managed and created populations of the coyote ceanothus. 10. Research should further explore plant pathogen introductions and potential impacts on managed and created populations of the coyote ceanothus. This should include not just Phytophthora, but also Fusarium and Botrytis, which are known to affect seedlings. 11. Identify additional habitat suitability needs and potential locations for another population creation site for the coyote ceanothus while taking into consideration climate change and atmospheric N deposition. 12. An additional seed banking effort should be conducted for all three extant populations (USFWS, 2023).

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# SPECIES ACCOUNT: *Ceanothus ophiochilus* (Vail Lake ceanothus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/13/1998; California/Nevada Region (R8) (USFWS, 2015)

**Physical Description**

A rounded shrub, usually 1.2-1.5 m (4-5 feet) tall. The flat, dull green leaves are opposite, with knob-like stipules, narrowly oblanceolate (broadest above the middle and tapering toward the base) to obovate (eggshaped) in shape, glabrous (smooth), with obscure veins and blades 3 to 7 mm long and 1 to 3 mm wide; fruits are 3 to 3.5 mm wide, and without horns (Wilken 2012, p. 1158). Flowers are pale blue, occasionally pink, in bloom from mid-February to March. (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Ceanothus ophiochilus is a narrow, edaphic endemic plant found only within 20 acres in Southwestern Riverside County, California (Fish and Wildlife Service 1998). (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 9/27/2007.

**Legal Description**

On September 27, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Ceanothus ophiochilus (Vail Lake ceanothus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes obe critical habitat unit (CHU), in California (72 FR 54984-55010).

**Critical Habitat Designation**

The critical habitat designation for Ceanothus ophiochilus includes one CHU (2 sub-units) in Riverside County, California. This species critical habitat encompasses approximately 283 acres (ac) (115 hectares (ha)) (72 FR 54984-55010).

Unit 1: Western Riverside County Unit 1 is located near Vail Lake in southern Riverside County, California. The area was occupied at the time of listing and contains all of the primary constituent elements essential to the conservation of the species that may require special management considerations or protection for Ceanothus ophiochilus. Below, we present a brief description of subunit 1B, reasons why it meets the definition of critical habitat for C. ophiochilus, and our rationale for our final designation of critical habitat. Subunit 1B, Agua Tibia Mountains, Riverside County, California Subunit 1B (Agua Tibia Mountains) consists of 203 ac (82 ha) of land which is managed by the USFS. Subunit 1B contains two of the three CNDDB element occurrences (2 and 3) of Ceanothus ophiochilus, both known at the time of listing. The PCEs within this subunit may require special management considerations or protection to address the threats posed by short-interval fires, competing nonnative species, impacts to ridge tops (PCE 1) from grading associated with the creation of fuel breaks and impacts to the associated vegetation community (PCE 3) resulting from unnatural fire regimes. Subunit 1B is entirely within the Agua Tibia Wilderness of the Cleveland National Forest. Recently the USFS completed the LMP for the Four Southern California National Forests. Implementation of the LMP was analyzed by the Service to address potential impacts to Ceanothus ophiochilus. This analysis found that impacts to C. ophiochilus would be minor or negligible upon implementation of appropriate minimization measures due to the lowimpact nature of activities planned (e.g., dispersed recreation, non-motorized trails) (Service 2005 p. 129–132). However, the LMP does not identify specific management measures to address the threat posed by shortinterval fires and by competing nonnative species (Keeley 2006, p. 367; Merriam et al. 2007, p. vi, v, 48, 61). Because the USFS does not have a management plan specific to C. ophiochilus that provides the same or better level of protection from adverse modification or destruction than that provided through a consultation under section 7 of the Act, we have determined that exclusion of these lands from the final designation of critical habitat pursuant to section 4(b)(2) of the Act is not appropriate for these Federal lands (please see ''Exclusions under Section 4(b)(2) of the Act'' for a detailed discussion). Therefore, we are designating the USFS lands containing features essential to the conservation of C. ophiochilus as critical habitat for this species.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Ceanothus ophiochilus critical habitat consists of three components (72 FR 54984-55010):

(i) Flat to gently sloping north to northeast facing ridge tops with slopes in the range of 0 to 40 percent slope that provide the appropriate solar exposure for seedling establishment and growth.

(ii) Soils formed from metavolcanic and ultra-basic parent materials and deeply weathered gabbro or pyroxeniterich outcrops that provide nutrients and space for growth and reproduction. Specifically in the areas that Ceanothus ophiochilus is found, the soils are: (A) Ramona, Cienaba, Las Posas, and Vista series in the Agua Tibia Wilderness; and (B) Cajalco series in the vicinity of Vail Lake.

(iii) Chamise chaparral or mixed chamise-ceanothus-arctostaphylos chaparral at elevations of 2,000 feet to 3,000 feet (610 meters to 914 meters) that provide the appropriate canopy cover and elevation requirements for growth and reproduction.

**Special Management Considerations or Protections**

As stated in the final listing rule, threats to Ceanothus ophiochilus include habitat destruction, alteration, fragmentation, and degradation from urban development, as well as hybridization and fire at too frequent intervals to allow for sufficient seed bank replenishment in the soil (63 FR 54956, October 13, 1998). Threats to Fremontodendron mexicanum as cited in the final listing rule include altered fire regimes, indirect impacts from nearby urbanization, and increased competition from nonnative species (63 FR 54965, October 13, 1998). These threats could impact the PCEs determined to be essential for conservation of C. ophiochilus and F. mexicanum. Urban development near Ceanothus ophiochilus critical habitat units may alter the habitat characteristics required by the species. Land grading in and around occurrences of C. ophiochilus may affect the topography of the habitat and change the soil composition (PCEs 1 and 2) rendering the habitat unsuitable for species growth and reproduction. Urban development may also encourage invasion by nonnative plant species, changing the vegetation community and/or directly impacting the vegetation community (PCE 3). In addition, urban development near this species may increase the frequency of fire. All identified private land is covered by the Western Riverside County MSHCP (MSHCP), and those lands have been excluded from the final designation (see ‘‘Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act’’ section for a detailed discussion). No urban development is expected to directly impact the occurrences of C. ophiochilus on land owned by the USFS. Therefore, we do not believe threats from urban development would require special management considerations or protection of the PCEs on designated critical habitat for this species. The management of both fire frequency and the placement of fuel breaks is important for the conservation of Ceanothus ophiochilus, and special management considerations or protection of the PCEs for C. ophiochilus may be required on USFS lands to address potential threats posed by fire management activities. In the past, fuel breaks have been placed on the ridgelines (PCE 1) in C. ophiochilus habitat and have caused soil disturbance (PCE 2). Studies of fuel breaks in the Cleveland National Forest near the critical habitat designation have demonstrated an increase in the density of competing nonnative species (Merriam et al. 2007, p. 48), and it has been hypothesized that fuel breaks promote the introduction and spread of nonnative plants (Merriam et al. 2007, p. vi). These nonnative invasive plants alter local fuel conditions and change fire behavior and frequency (Merriam et al. 2007, p. 61). Ceanothus ophiochilus is very sensitive to short-interval fires, which may extirpate the species from a site entirely (Keeley 2006, p. 367). Soil disturbance, caused by the creation of fuel breaks, has also led to increased hybridization between Ceanothus ophiochilus and C. crassifolius. However, the degree to which hybridization is impacting C. ophiochilus and its habitat is not yet known.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (hybridization) (USFWS, 2013)

**Breeding Season**

Adult: Mid-February to March (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Fire (USFWS, 2013)

**Reproduction Narrative**

Adult: Flowers are pale blue, occasionally pink, in bloom from mid-February to March (NatureServe, 2015). Hybridization is common among Ceanothus species (Wilken 2012, p. 1153; Fross and Wilken 2006, pp. 132–133). Ceanothus ophiochilus generally requires a firereturn interval between 10 to 20 years to adequately replenish the seed bank (Keeley and Davis 2007, p. 350). Ceanothus ophiochilus is an obligate seeder and therefore does not resprout following fire, but instead recovers through the germination of seeds stored in the soil (Boyd and Banks 1995, p. 28; Keeley 2006, p. 367). (USFWS, 2013)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2013)

**Habitat Vegetation or Surface Water Classification**

Adult: Shrubland/chaparral

**Dependencies on Specific Environmental Elements**

Adult: Fire (USFWS, 2013)

**Spatial Arrangements of the Population**

Adult: Isolated patches (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Habitat Narrative**

Adult: Ceanothus ophiochilus is restricted to isolated patches of gabbro and pyroxenite-rich outcrops (Vail Lake), or within a mix of gabbro and sedimentary deposits (Agua Tibia Wilderness) (Boyd and Banks 1995, p. 15). It is generally found within chamise chaparral habitats on ridge tops and north- to northeast-facing slopes (USFWS, 2013). Ceanothus ophiochilus generally requires a firereturn interval between 10 to 20 years to adequately replenish the seed bank (Keeley and Davis 2007, p. 350). (USFWS, 2013)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: Many plant species with refractory seeds (i.e., seeds that need a fire-related stimulus, alone or in conjunction with other conditions; Keeley 1991, p. 87) have propagules that are not specialized for widespread dispersal and therefore have a relatively short dispersal distance (Keeley 1991, p. 105). Ceanothus plants have capsules that eject seeds and studies on two Sierra Nevadan Ceanothus species, C. cuneatus and C. leucodermis, found that most seeds fall beneath the canopy vegetation (Evans et al. 1987, p. 288); even on open sites, few seeds (less than 2 percent) reached a distance of 29.5 ft (9 m) (Evans et al., 1987, pp. 288–289). (USFWS, 2013)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

3 (USFWS, 2013)

**Population Size:**

~10,000

**Population Narrative:**

One populations consists of about 3,000-5,000 individuals and occupies about 8 hectares; the remaining two populations comprise over 4,000 individuals in a 12 hectare area (Fish and

Wildlife Service 1998). Known from only three occurrences near Vail Lake, California (Skinner 1997). (NatureServe, 2015).

***Threats and Stressors***

**Stressor:** Urban development (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, the Service indicated that much of southwestern Riverside County was expected to become more urbanized based on development trends and planned developments on private lands in the Vail Lake area (USFWS 1998, p. 54961). In the 2008 5-year review, the Service reevaluated the proposed developments for this area and stated that the most recently proposed, large-scale development (Specific Plan No. 324) for this area had not been acted upon and the project was inactive (USFWS 2008, p. 8). However, the Service concluded that urban development in the Vail Lake area remained a significant threat to the Vail Lake occurrence of Ceanothus ophiochilus since no assurances of the conservation of this species have been made (USFWS 2008, p. 8). In summary, the Service believes that urban development represents a potential threat to Ceanothus ophiochilus at two of the three occurrences. (USFWS, 2013)

**Stressor:** Recreational activities (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Dispersed recreation (e.g., camping, hiking, mountain bike activity) is an occasional, ongoing use at the Agua Tibia Wilderness occurrences (USFS 2012b, p.41). The use of exiting trails or the creation of new trails within the Agua Tibia Wilderness occurrences located on CNF lands represents a potential threat to Ceanothus ophiochilus primarily from soil compaction of habitat, although trampling of individual plants may also result from these activities. However, no designated USFS trails currently intersect with habitat occupied by C. ophiochilus (USFS 2012b, p. 41) and the recreational use, although allowed in or near the two Agua Tibia Wilderness occurrences within CNF by the public, is limited because access is controlled by adjacent private lands (USFS 2012b, pp. 40–41). (USFWS, 2013)

**Stressor:** Invasive non-native plants (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive nonnative plants have been identified by the USFS as a threat to habitat quality for Ceanothus ophiochilus, particularly in those areas within the Agua Tibia Wilderness occurrences where recent wildland fire has exposed bare soils and created unclassified trails as a result of fire suppression activities (USFS 2005a, p. 259). Roads and road construction from grading of fuel breaks facilitate the introduction and establishment of invasive nonnative plants (discussed above) by creating open, continually disturbed habitat. Invasive nonnative plants can also be transported along these corridors by equipment and other vehicles, as well as recreational uses, and can become more readily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005e, Volume 1, p. 114). Activities conducted by the USFS

associated with the removal of invasive plants may have short-term adverse effects to Ceanothus ophiochilus. (USFWS, 2013)

**Stressor:** Wildland fire and fire Management (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the USFWS listing rule, the Service identified the change in fire cycle regimes (or fire frequency) as a threat to Ceanothus ophiochilus and other plants adapted to specific fire frequencies (USFWS 1998, p. 54964). Changes occurred from increased incidence of local accidental fires and less frequent natural fires resulting from human activity in fire prone areas (e.g., Vail Lake occurrence). The Service also highlighted fire management practices including grading of C. ophiochilus habitat for fire or implementation of fuel breaks as an important threat to this species for all three occurrences (Boyd 1991, pp. 2, 8; Boyd and Banks 1995, p. 16; USFWS 1998, p. 54961). Fire management and suppression activities including fire line construction, fire retardant and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation can affect Ceanothus ophiochilus habitat (USFWS 2005, p. 27). (USFWS, 2013)

**Stressor:** Hybridization and introgression (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service identified hybridization and genetic introgression with C. crassifolius as a major threat to C. ophiochilus where the two species co-occur in our 2008 5-year review (USFWS 2008, p. 14). Without genetic evaluations and comprehensive surveys within the three occurrences, it is difficult to assess the nature and extent of hybrid individuals; thus, it is unclear if hybridization or introgression represents a current threat to C. ophiochilus at this time. Continued monitoring of disturbance to all three occurrences is needed in conjunction with additional genetic viability studies to better evaluate these two related threats to C. ophiochilus. (USFWS, 2013)

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Based on the best available information contained in model predictions for this general region of California, a change in temperature conditions resulting from climate change is considered a rangewide threat to Ceanothus ophiochilus due to predicted changes to its habitat. Climate model predications also indicate a slight increase in fire risk to the geographical range of C. ophiochilus, which, when combined with anthropogenic facilitation, can produce a shortening of the fire return interval and affect its ability to recover and maintain its viability in the chaparral ecosystem. (USFWS, 2013)

**Stressor:** Climate Change - New Information (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** TEMPERATURE Temperature across southern California has increased over the past century. He and Gautam (2016) analyzed 1896–2015 temperature records for the region. They reported that annual average, maximum, and minimum temperature all increased by around 0.16 degree Celsius per decade (p. 11). Projected temperature increases differ spatially across southern California. The ocean buffers warming near the coast, so coastal areas are projected to experience relatively smaller temperature increases (Hall et al. 2018, p. 11). But inland areas—such as the range of Ceanothus ophiochilus in western Riverside County—are projected to have relatively larger temperature changes under both emissions scenarios (Hall et al. 2018, p. 11). Extremely hot days are also projected to become more frequent and intense, with the largest changes in interior regions (Hall et al. 2018, p. 11). For the range of Ceanothus ophiochilus in Western Riverside County, annual average maximum temperatures under RCP 4.5 are projected to increase from an observed historical (1961–1990) average of 77.2 degrees Fahrenheit (F) [25.1 degrees Celsius (C)] (range 75.8–80.0 degrees F, 24.3–26.7 degrees C), to a projected future (2070–2099) average of 82.9 degrees F (28.3 degrees C) (range 79.8 –86.0 degrees F, 26.5–30.0) (Cal-Adapt 2020). Under RCP 8.5, end-of-century (2070–2099) annual average maximum temperatures are projected to rise to 85.7 degrees F (29.8 degrees C) (range 81.4–90.6 degrees F, 27.4–32.5 degrees C). For projections of future temperature, RCP 4.5 and 8.5 scenarios are similar in the early and mid-21st century. Projections diverge in the second part of the century, as emissions continue to rise under RCP 8.5 (Hall et al. 2018, p. 10). PRECIPITATION Precipitation in southern California is highly variable from year to year (Kalansky et al. 2018, p. 24; Hall et al. 2018, p. 12). Models of future precipitation generally project small mean changes relative to the historical variability, and the overall direction of future precipitation is unclear (Hall et al. 2018, p. 13). Models do project increases in extreme precipitation frequency and intensity (Polade et al. 2017, p. 7; Swain et al. 2018, p. 428), including increases in the frequency of atmospheric-river storms, which deliver intense precipitation and can cause severe flooding (Dettinger 2011, p. 519). However, droughts are also projected to become more frequent and intense, and will be exacerbated by higher temperatures (Kalansky et al. 2018, p. 25). ATMOSPHERIC CO2 CONCENTRATION Since 1750, the atmospheric concentrations of greenhouse gasses (including carbon dioxide, methane, and nitrous oxide) have increased because of human activity (IPCC 2013, p. 11). In 2011, the concentration of carbon dioxide ($CO_2$) was 391 parts per million (ppm), 40 percent higher than pre-industrial levels (IPCC 2013, p. 11). In 2018, the global average atmospheric carbon dioxide ($CO_2$) concentration was 407.4 parts per million (ppm) (Lindsey 2020). Plants use $CO_2$ and water to synthesize carbohydrates. Therefore, elevated $CO_2$ concentrations can directly affect photosynthesis. FIRE California has a Mediterranean climate with cool, wet winters and hot, dry summers. Fire is an important part of California ecosystems. Fire behavior is influenced by topography, weather, fuel characteristics, and ignition sources (van Wagtendonk 2006, pp. 38–46). Santa Ana winds—strong, dry, and hot winds occurring mostly in September through December (Hughes and Hall 2010, p. 847; Jin et al. 2015, pp. 1–2)—are one feature of the southern California climate which can influence wildfire behavior and size. Wildfires driven by Santa Ana winds (Santa Ana fires) spread more quickly, and have higher intensity, than fires that occur outside the Santa Ana season (Jin et al. 2015, pp. 5–6). For California's Fourth Climate Assessment, Pierce et al. (2018) projected an increase in the driest of Santa Ana days (daily wind speeds greater than or equal to 8 meters per second, and less than or equal to 20 percent relative humidity), although the number of Santa Ana days and the days with the strongest wind speeds were projected to decrease (Pierce et al. 2018, p. 36; Kalansky et al. 2018, p. 27). There is uncertainty in future wildfire projections for southern California (Hall et al. 2018, p. 18), but wildfire risk will likely increase as climate warms (Kalansky et al. 2018, p. 6). Under RCP 8.5, Westerling (2018, p. 19) projected an increasing tendency towards extreme wildfire events, rapidly accelerating after the mid-21st century. Statewide, the greatest increases in burned area were projected to be in forested areas of the state (Westerling 2018, p. 14). For southern California under RCP 8.5, Jin et al. (2015, p. 9–10) projected increases in burned area, number of fires, and fire size for both Santa Ana and non-Santa Ana fires. (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 8C

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**

- Recovery actions are not available.
- Continue to work with the CNF to ensure that USFS guidelines and directives are being implemented for activities that might directly or indirectly impact Ceanothus ophiochilus habitat. This should include providing comment on biological assessments for proposed fire suppression activities and assistance in designing fuel breaks to protect populations of C. ophiochilus. (USFWS, 2013)
- Conserve or preserve Ceanothus ophiochilus occurrences on private lands, especially at Vail Lake. Pursue opportunities to purchase parcels through the Act’s section 6 funding and other conservation partnership programs (i.e., Western Riverside County MSHCP) with willing sellers. (USFWS, 2013)
- Develop outreach or educational activities with the primary landowner adjacent to the Agua Tibia Wilderness–North occurrence to enlist their assistance in ensuring the survival and recovery of Ceanothus ophiochilus. (USFWS, 2013)
- Develop a monitoring plan for populations of Ceanothus ophiochilus, the quality of chamise chaparral habitats, and threats at the three C. ophiochilus occurrences. This monitoring plan should include surveys to detect abundance, habitat conditions, and potential threats to the taxon, particularly those related to the effects of fire and fire management activities. (USFWS, 2013)
- Determine the current level and pattern, extent, and impact of introgression of Ceanothus ophiochilus with C. crassifolius at all three occurrences. (USFWS, 2013)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Work with the Rancho California Water District to conserve and enhance the Vail Lake occurrence of Ceanothus ophiochilus. 2. Survey suitable habitat for new occurrences of C. ophiochilus. 3. Survey for nonnative invasive plants in the vicinity of C. ophiochilus occurrences. 4. Model C. ophiochilus habitat under a range of future climate scenarios, and evaluate assisted migration or translocation as a management strategy. 5. Determine the current level and extent of introgression of C. ophiochilus with C. crassifolius, and reexamine putative hybrids. 6. Collect additional C. ophiochilus seeds for ex situ storage at a certified Center for Plant Conservation facility. (USFWS, 2020)

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# SPECIES ACCOUNT: *Ceanothus roderickii* (Pine Hill ceanothus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/18/1996; California/Nevada Region (R8)

**Physical Description**

A prostrate evergreen shrub of the buckthorn family (Rhamnaceae) that generally grows to 3 meters (9.8 feet) in diameter. The smooth gray-brown branches radiate from a central axis and root when they come into contact with the ground. Its leaves are semi-erect with entire (smooth-edged) margins. Small whitish flowers tinged with blue appear from May through June. Its fruit is an inconspicuously horned, globe-shaped capsule. Ceanothus roderickii can be differentiated from its congeners (other species of the same genus, other related species) by a combination of its blue-tinged flowers, prostrate habit, and inconspicuously horned fruit. (USFWS, 2002)

**Taxonomy**

Walter Knight (1968) described Ceanothus roderickii as Ceanothus rodericki, naming it after Wayne Roderick, who first recognized the horticultural value of this endemic shrub. Due to an orthographic change, the correct spelling is Ceanothus roderickii. Knight (1968) considered C. roderickii to be most closely related to C. cuneatus (buckbrush), which also grows throughout the area. Ceanothus roderickii is suggested to resemble the sprawling C. fresnensis (Fresno mat), which grows a considerable distance to the south at higher elevations; plants of the two species grown in a regional park flowered at different times (Knight 1968). (USFWS, 2002)

**Historical Range**

Endemic to western El Dorado County, California. (USFWS, 2002)

**Current Range**

On the Pine Hill formation in western El Dorado County, California.(USFWS, 2019). The species is restricted to the Pine Hill Preserve and the immediate vicinity (USFWS, 2024).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: The pollination of Ceanothus roderickii is primarily by insects from the orders Diptera (flies and gnats) and Hymenoptera (bees and wasps). (USFWS, 2002)

**Breeding Season**

Adult: May to June (USFWS, 2002)

**Key Resources Needed for Breeding**

Adult: Fire/heat (USFWS, 2002)

**Reproduction Narrative**

Adult: Flower/fruit development in this species is negatively affected by canopy shading (James 1996). Unlike most chaparral shrub species, Pine Hill ceanothus will not resprout from a caudex (woody axis comprising the stem and root) after a fire, and therefore, depends on nearby plants connected via branch layering for survival or the seedbank for re-establishment (Boyd 2007). There is reason to believe that seeds can survive at least 80 years in the seedbank (Ayres 2011; Boyd 2007). Hot/cold stratification, but not necessarily fire (Boyd 2007), seems to be required for germination (James 1996; Boyd 2007). Because juvenile plants do not begin flowering until 5-6 years after fire, populations need a fire-free period of at least six years to replenish the seed bank (Marsh and Ayres 2002; Ayres 2011), otherwise populations may be permanently lost. (USFWS, 2019)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Barrens, Shrubland/chaparral (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Combination of heat and cold (USFWS, 2002)

**Geographic or Habitat Restraints or Barriers**

Adult: Shading limits flower production (USFWS, 2002)

**Spatial Arrangements of the Population**

Adult: Scattered (USFWS, 2002)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2002; NatureServe, 2015)

**Habitat Narrative**

Adult: Ceanothus roderickii is found in openings in chaparral communities on gabbro- or serpentinite- derived soils (NatureServe, 2015). Most occurrences are discontinuously scattered within two population centers in the northern and southern portions of the Pine Hill formation. The seeds treated with a combination of heat and cold have the best germination rate. Canopy shading was shown to negatively affect flower and fruit production in C. roderickii. (USFWS, 2002)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019)

**Number of Populations:**

2 known extant ; 7 presumed extant (USFWS, 2019)

**Population Size:**

Greater than 55,000 individuals (USFWS, 2019)

**Additional Population-level Information:**

Botanical surveys were conducted around the perimeter of Pine Hill in conjunction with a fuels reduction project that created a 20–25-meter firebreak around the reserve between 2017–2019 (Klip et al. 2020, p. 59). Ten new patches of Pine Hill ceanothus were found during these surveys (Klip et al. 2020, p. 65). These new patches of plants are within proximity to other areas occupied by the species on Pine Hill and thus do not change our overall understanding of the distribution of the species. In addition, germination and survival of Pine Hill ceanothus on the reserve was monitored in plots with three different treatments: burned piles, hand-cleared and unburned, and intact chaparral (Klip et al. 2020, pp. 59, 61). Pine Hill ceanothus seedlings were found at higher densities in plots where piles had been burned, suggesting that pile burning could be used by land managers to promote germination of Pine Hill ceanothus (Klip et al. 2020, pp. 74–75). Purple false brome (Brachypodium distachyon), an exotic grass which thrives in mature chaparral and is eliminated by neither fire nor clearing, has been noted on Pine Hill in the two treatments within the ongoing studies on post-fire regeneration conducted by the El Dorado Chapter California Native Plant Society (See further discussion in Threats section; Klip et al. 2020, pp. 67, 73). (USFWS, 2024)

**Population Narrative:**

It is restricted to one localized area of approximately 10 occurrences discontinuously scattered in the Pine Hill formation in the north, central, and south areas (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range. (USFWS, 2002)

**Stressor:** Habitat fragmentation (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The subsequent induced growth from water acquisitions would affect all six species on the Pine Hill formation and adjacent serpentine, either by further fragmenting the habitat or by directly destroying habitat. Habitat fragmentation and edge effects significantly affect gabbro plants. Habitat fragments are more susceptible to being burned in their entirety, with shorter than natural intervals between fires, relative to larger tracts of habitat. If an entire preserve

burns more often than the natural fire frequency, the seed bank of certain chaparral shrub species may not be adequate to replace the population. Fragmentation splits habitat into smaller, more isolated units and has two primary effects. First, habitat fragmentation may alter the physical environment, changing the amount of incoming solar radiation, water, wind, or nutrients for the remnant vegetation (Saunders et al. 1991). Second, most of these fragmented natural areas are subject to influences from external factors (e.g., additional development, lawn and garden watering, herbicide drift, and off-road vehicular use) that disrupt natural ecosystem processes. (USFWS, 2002)

**Stressor:** Fire management (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes in fire frequency threaten Ceanothus roderickii. C. roderickii occur within a fire-adapted plant community, either within chaparral or on the ecotone between chaparral and woodland. Before the advent of fire suppression policies, chaparral stands may have burned at a frequency of roughly 3 to 5 times per 100 years (Boyd 1985). Longer than normal fire frequencies lead to the loss of some plant species from the chaparral plant community. (USFWS, 2002)

**Stressor:** Hydrologic changes (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** El Dorado Irrigation District, is attempting to get additional water from the South Fork of the American River through purchase of PG&E’s Hydroelectric Project 184 and a storage contract with the Bureau of Reclamation utilizing Folsom Reservoir. This water is most likely to be used for developments in the extreme western part of El Dorado County, where the gabbro soil plants are found (A. Howard in litt. 1999). (USFWS, 2002)

**Stressor:** Development (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mitigation for development often is by small "set asides" (small natural areas within the development), which increase habitat fragmentation, are difficult to manage for fire, and are subject to edge effect problems. Land development and multiple ownership complicate the planning and implementation of controlled burns at the appropriate fire frequency necessary for maintenance of chaparral. (USFWS, 2002)

**Stressor:** Road widening and maintenance (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road widening occurs near development within El Dorado County threatens the habitat of Ceanothus roderickii at one site (California Natural Diversity Data Base 1994). (USFWS, 2002)

**Stressor:** Recreation (USFWS, 2002)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-road vehicle use has adversely affected the habitat of Ceanothus roderickii at three sites in the northern part of the Pine Hill formation. Several hills are scarred with off-road vehicle tracks. Erosion promoted by scarring adversely modifies the habitat. (USFWS, 2002)

**Stressor:** Invasive plants (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). (USFWS, 2019)

**Stressor:** Alteration of the natural fire regime, herbicide spraying, unauthorized dumping, invasive species, and shading via succession (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Alteration of the natural fire regime, herbicide spraying, unauthorized dumping, invasive species, and shading via succession were also listed as threats to Stebbins' morning-glory, Pine Hill ceanothus, Pine Hill flannelbush, and Layne's butterweed in the listing rule (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
1. Secure and protect specified recovery areas from incompatible uses: (a) Cameron Park preserve north of Highway 50; (b) Cameron Park preserve south of Highway 50; (c) Pine Hill preserve; Salmon Falls/Martel Creek preserve; (d) sufficient adjacent unoccupied habitat for fire management and a 150- meter (500-foot) buffer. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For preserves and any adjacent occupied or unoccupied habitat identified as necessary for continued survival and recovery (USFWS, 2002).

3. Monitoring in all recommended preserves shows: (a) populations stable or increasing over one fire cycle (about 30 years), (b) habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions, (c) spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats; (b) Fire management studies; (c) Research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary; (d) Maintain metapopulation dynamics of at least 2 very large, 2 large, 6 medium,

and 7 small occurrences throughout the range of the species. (USFWS, 2002)

Recovery Priority Number: 5C

**Delisting Criteria:**
1. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all occurrences and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

2. Monitoring in all recommended preserves shows: (a) no decline after downlisting during two additional fire cycles (about 60 years); if declining, determine cause and reverse trend, (b) habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions, (c) spatially and temporally, the establishment of occurrences must be at least 10 percent greater than the extirpation of occurrences. (USFWS, 2002)

3. Ameliorate or eliminate threats; research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary. (USFWS, 2002)

**Recovery Actions:**
- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable

for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)

- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Reproduction and Demography Research: Including determining limiting life stages, seed production, and survival in soil to determine appropriate fire return period. Systematics research and genetic studies if repatriation is determined to be necessary. Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- Pine Hill ceanothus 1. Further investigate the prevalence and survival of Pine Hill ceanothus/buck brush hybrids in disturbed and undisturbed conditions (USFWS, 2024)

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# SPECIES ACCOUNT: *Cereus eriophorus var. fragrans* (Fragrant prickly-apple)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/2/1985; Southeast Region (R4)

**Physical Description**

Cereus eriophorus var. fragrans is a solitary tree cactus that may have from one to eight, spiny, cane-like, stout, and succulent stems. The columnar stems are 2.5 to 5.0 cm in diameter, and have 10 or 12 ridges alternated with deep, sharp grooves (Benson 1982). Stems may be erect, or for longer stems, the plant may recline over neighboring vegetation. The branching can be extensive, and the roots of this cactus are coarse, fibrous, and shallow (Small 1920). The spine-bearing regions (areoles) are aligned along its ridges about 2 cm apart. Each areole bears 9 to 13 spines, which are mostly grayish and yellowish at the tip, with one spine longer (2 to 4 cm) than the rest. Cereus eriophorus var. fragrans has initial flower buds that are 1 cm long, white, and exceedingly hairy. Buds often appear on the plant one to two months prior to flower growth. About 9 days after initiation of flower growth, the flower opens (Rae 1995). The flowers are fragrant, showy, solitary, and open only at night. The buds are 12 to 20 cm long when about to open and 7.5 to 10 cm in diameter when open. The ovary bears many lanceolate scales while the flower tube has only a few scattered scales. A tuft of long white hairs (10 to 15 mm long) protrudes from the axil beneath each scale. The sepals are narrowly linear, with green outer sepals and nearly white inner ones. There are numerous spatulate petals, white or pinkish, with unevenly toothed margins. The stamens are numerous and are composed of white filaments and yellow anthers. The style is elongate with 9 to 12 stigmas (FWS 1988). The fruits are attached at the narrower end. They average 4 to 6 cm in diameter and are a dull red. The fruit does not split and has long tufts of white hairs that remain persistent with the scale bases (Leon and Alain 1953). The fruits are swollen at the base and finely pitted; each contains approximately 1,500 black seeds that are about 3 mm long (Rae 1995). (USFWS, 1999)

**Taxonomy**

The type specimen was collected by John K. Small in 1917 along sand dunes approximately 6 miles (mi) south of Ft. Pierce, Florida, and treated as Harrisia fragrans (Britton and Rose 1920). It was separated from other species partly on the basis of having one longer spine than the other 9 to 13 spines per areole (Britton and Rose 1920). Austin (1984) followed the treatment of Lyman Benson (1982) in which Harrisia and other cacti were joined together in the genus Cereus. Since then, fragrant prickly-apple has consistently been referred to by its former name, Harrisia, in references to the flora of the United States and Florida (Chafin 2000; Gann et al. 2002; Flora of North America 2003; Wunderlin and Hansen 2003). The Integrated Taxonomic Information System (2010) was also checked while conducting this review and indicated that the accepted name is Harrisia fragrans. Because Harrisia fragrans is the name used in peer-reviewed literature and is accepted by the scientific community, we concur with this nomenclature. (USFWS, 2010)

**Historical Range**

Historically occurred on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties (USFWS, 2010)

**Current Range**

In Florida, in Volusia and St. Lucie Counties, projected to include Brevard and Indiana River Counties. (USFWS, 2010)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexually and by regeneration by vegetative reproduction

**Breeding Season**

Adult: Plants flower from April to September with two distinct peaks. (USFWS, 2016)

**Reproduction Narrative**

Adult: Fragrant prickly-apple reproduces sexually and by regeneration by vegetative reproduction. Plants flower from April to September with two distinct peaks. The first peak is in the spring with flowering starting in April and reaching a peak in May. Some sporadic flowering occurs in the summer. In September and October, another minor peak in flowering occurs. Flowering is uncommon in the late fall, and no flowering occurs from January through March. Fruit set follows flowering with a major peak in May and a minor peak in September. A large standing crop of fruit remains on plants for approximately 8 months of the year. According to Rae (1995), mature plants are greater than 41 cm in length. The smallest plant to flower was 14.5 cm in stem length and the smallest plant to set fruit was 41 cm in length. In his study, 63 percent of the mature plants flowered. At two sites in the Savannas State Preserve, in St. Lucie County, 38 and 60 percent of flowers successfully produced fruits and 44 and 61 percent of mature plants successfully set fruit. A positive relationship was observed between total length of the stems and branches of a plant and the total annual production of fruit. The means of seed dispersal are uncertain, but there is evidence that birds consume the fruit of fragrant prickly-apple. Additionally, most individuals of this species are found within the drip line of other plants, suggesting avian seed dispersal. Rodents or gopher tortoises may also distribute the seeds. In addition to sexual reproduction, long stems will occasionally snap off of existing plants. After falling to the ground, stems may re-root at several places creating a small group of genetically identical plants (Rae 1994a). Vegetative growth of this perennial species is slowest from November to March. Growth accelerates in April and May, with the fastest growth occurring from July through September. The growth rate drops off rapidly after September (Rae 1994a, 1995). The fragrant prickly-apple is characterized as a long-lived species with late maturity, low fecundity, and low adult mortality (Rae and Ebert 2002). Larger plants tend to have higher fecundity and lower mortality rates (Rae and Ebert 2002); therefore, the larger individuals in the population are extremely important to overall population health (Rae and Ebert 2002). (USFWS, 2016)

**Habitat Type**

Adult: Sand pine scrub habitat

**Environmental Specificity**

Adult: Narrow (USFWS, 2016)

**Habitat Narrative**

Adult: Fragrant prickly-apple occurs in a clumped distribution and prefers early-successional sand pine scrub habitat (Rae 1994b, 1995). The known sites are limited to St. Lucie sand which is excessively well drained (Watts and Stankey 1980), where the water table is normally deeper than 3 m. Water capacity, fertility, and organic matter content are all very low. The most common plant species in this community include sandhill jointweed (Polygonella fimbriata), hairy jointweed (P. ciliata), tall jointweed (P. gracilis), sand live oak (Quercus geminata), myrtle oak (Q. myrtifolia), cabbage palm (Sabal palmetto), and pricklypear (Opuntia humifusa). Much of the Atlantic Coastal Ridge was cleared in the 1880s for pineapple plantations, but commercial pineapple cultivation was abandoned by 1920. The vegetative community has yet to regain its previous level of diversity or productivity. The vegetative succession has been arrested and the plant community has not succeeded to the climax sand pine habitat type (Rae 1994a, 1995). This cactus prefers partial shade, which is often provided by surrounding plants that shelter it from sun for a portion of the day (Rae 1994b). Surrounding vegetation is often used for support by fragrant prickly-apple for its long stems. Other plants may serve as nurse plants for the seedlings, protecting them from direct sun, but this has not been studied. As the plant grows, the nursery plant may die, leaving the cacti exposed to a greater intensity of sunlight. Overgrowth and shading by sand live oaks and other species may cause reproductive failure and premature death. Growth and productivity seems to be greater for plants in areas that are partially shaded. (USFWS, 2016)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

7 (six natural and one introduced) (USFWS, 2021)

**Population Size:**

Less than 1,200 individuals (USFWS, 2021)

**Population Narrative:**

Fragrant prickly-apple was listed as endangered on November 1, 1985, following substantial losses of suitable habitat (50 FR 45621). At the time of listing, fragrant prickly-apple was only known from St. Lucie County (Service 1985). Historically, fragrant prickly-apple occurred in coastal hammock habitats on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties, although some accounts in other areas were erroneously reported due to misidentification with Simpson's prickly-apple (Cereus gracilis var. simpsonii) (Service 1985; Service 1999; Woodmansee et al. 2007). Fragrant prickly-apple was reportedly collected in Everglades National Park (ENP), but this is not confirmed (NPS 2007; Sadle 2009). Because Simpson's prickly-apple commonly occurs in ENP, there is much confusion over identification of these two species, there is no voucher specimen available in herbarium collections for confirmation, the fragrant prickly-apple is limited in distribution, and ENP lacks the habitats believed to support fragrant prickly-apple, it is thought that the species was misidentified (NPS 2007; Sadle 2009). The species is now known to occur on only 10 confirmed sites in Volusia and

St. Lucie Counties, primarily on or around Savannas Preserve State Park (SPSP) where the site covers an area approximately 10.0 mi long and 0.5 mi wide and is bisected by the Florida East Coast railway (Bradley et al. 2002; Bradley and Gann 2002; Woodmansee et al. 2007; Florida Natural Areas Inventory [FNAI] 2009). These cacti are often found to occur in distinct clusters (Bradley et al. 2002; Woodmansee et al. 2007). The occurrence of fragrant prickly-apple in Indian River County is yet unconfirmed because only a single sterile plant was observed on a coastal berm when surveys were conducted in 2006 (Woodmansee et al. 2007; FNAI 2009). Although only confirmed in Volusia and St. Lucie Counties, it is possible that the current range of the species includes Brevard and Indian River Counties, as these counties occur between confirmed locations and appropriate habitat is available (Woodmansee et al 2007).(USFWS,2016). Fragrant prickly-apple is a narrow-ranging species, occurring in just four Florida counties along the Atlantic Coastal Ridge (St. Lucie, Indian River, Brevard, and Volusia). There are currently only seven extant populations (six natural and one introduced) (Table 1). With the recent discoveries of the cacti in Indian River and Brevard counties, the number of known populations has increased; however, the sites where it occurs are fragmented, disjunct, and isolated from each other. Despite newly identified populations and a reintroduction effort, the total number of fragrant prickly-apples has declined from an estimated 3,000 individuals in 2007 (Service 2010) to fewer than 1,200 in 2020 (Table 1; Woodmansee et al. 2007; Kneifl 2020a; Moore 2020a, 2020b; Rogers 2020; van den Ende 2020a; Service unpublished data record). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Continued habitat loss, fragmentation, and changes in land use threaten the existence of fragrant prickly-apple. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. For example, Woodmansee et al. (2007) suggested that the two extirpated sites in Brevard County were probably lost due to habitat alteration or destruction and severe freezes. Moore (2009) stated that another private site known to contain fragrant prickly-apple was to be sold for development a few years ago. After obtaining permission to salvage the cactus from the property, he returned to find that it had already been removed (Moore 2009). - Threats from development and habitat degradation on private sites are expected to continue and increase. Within the range of fragrant prickly-apple, the human population is predicted to grow from just below 500,000 to nearly 1,000,000 in Volusia County and from approximately 193,000 to more than 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Carr 2006). - Even though 63 percent of the sites around SPSP containing fragrant pricklyapple are publicly owned and not at risk of being developed, the plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Because population densities tend to vary over time, even those sites with high population densities may be vulnerable if not monitored carefully (Rae in litt. 2010). Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in coastal scrub habitat and the

encroachment of exotic plants continue to threaten fragrant prickly-apple. (USFWS, 2010)

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, overutilization was identified as a potential threat for fragrant prickly-apple, but indiscriminate collecting was not known to occur. Because it is limited in distribution and population sizes are relatively small, indiscriminate collecting could adversely affect the species. Like many other species of cacti, fragrant prickly-apple is vulnerable to unlawful exploitation and collection due to the activities of some collectors and hobbyists. Enforcement is difficult due to insufficient resources and the remoteness of the plants. There is minor horticultural interest in this species (Bradley and Gann 2002). During the 5 years of monitoring that took place at SPSP, there was no evidence of poaching (Bradley and Gann 2002). However, the salvage of a fragrant prickly-apple from a property slated to be sold for development was planned but never occurred because the plant was mysteriously removed before the rescue could be implemented (Moore 2009). The Service believes that there is a continuing threat from overutilization for commercial or recreational purposes. (USFWS, 2010)

**Stressor:** Disease or predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** When the fragrant prickly-apple was listed as endangered, disease and predation were not known to be threats. However, insects may damage cacti. Moore (2009) noted that young seedlings were damaged when unidentified caterpillars ate the sprouts. A native scale insect, Diaspis echinocacti, has been found to destroy stems of the fragrant pricklyapple in SPSP; however, it does not appear to kill the host plant (Bradley et al. 2002a; Bradley and Gann 2002). Root parasitism may occur when fragrant 10 prickly-apple grows in association with tallow wood (Ximenia Americana) or graytwig (Schoepfia chrysophylloides) but has not been directly observed (Bradley and Gann 2002). Fragrant prickly-apple may also be parasitized by love-vine. There is evidence that birds eat the fruit and serve as a mechanism to disperse seeds (Service 1999). It is also thought that rodents or gopher tortoises may distribute seeds (Service 1999). These occurrences of predation and parasitism are not known to constitute serious threats to the fragrant prickly-apple. (USFWS, 2010)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The ESA provides limited protection for the species and its habitat. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The fragrant prickly-apple is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. Title 62D2.013 of the Florida Administrative

Code prohibits the removal, destruction, or damage of plants from FDEP, Division of Recreation and Park properties. This regulation provides protection for much of the population where it occurs on SPSP. - Existing regulatory mechanisms do not appear to be adequate, as several properties with fragrant prickly-apple on private lands have been developed. Fragrant prickly-apple was potentially impacted in 2005 when heavy equipment was used to push debris into habitat where the species was presumed to occur along the railroad right-of-way (Kaufmann 2005). Multiple portions of potential habitat along the railroad tracks are being purchased and used to dump dredged material from the Intracoastal Waterway along the Indian River. - Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development and other uses due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. (USFWS, 2010)

**Stressor:** Prescribed fire (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Land management practices such as prescribed fire are important to maintaining the scrub ecosystem. However, the fragrant prickly-apple is intolerant of fire (Bradley and Gann 2002). Because it is thought that the species was historically located along the perimeter of scrub habitat in xeric hammocks, it may not have been affected as frequently by fires that were occurring in adjacent scrub (Bradley and Gann 2002). (USFWS, 2010)

**Stressor:** Invasive nonnative plant species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A large source of habitat degradation is the establishment of invasive plant 11 species such as Brazilian pepper (Schinus terebinthifolius), rosary pea (Abrus precatorius), white cypress pine (Callitris glaucophylla), golden trumpet (Allamanda cathartica), cathedral bells (Kalanchoe pinnata), chandelier plant (K. tubiflora), swamp mahogany (Eucalyptus robusta), guinea grass (Panicum maximum), and Crow's foot grass (Dactyloctenium aegyptium) (Bradley and Gann 2002; Bradley et al. 2002b). These invasive species may impact fragrant prickly-apple growth, reproductive potential, and recruitment by competing for space and nutrients and blocking sunlight (Bradley and Gann 2002). The species frequently grows beneath the canopy of these invasives to take advantage of partial shade and also can be crushed beneath falling limbs or trees not able to withstand hurricane winds (Bradley and Hines 2007). However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the fragrant prickly-apple. Bradley and Hines (2007) noted mortality as a result of off-target herbicide application at SPSP. (USFWS, 2010)

**Stressor:** Feral hogs, tortoise, and inadequate land management (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Degradation to habitat can also occur from damage by feral hogs (Engeman et al. 2003, 2004). Bradley and Hines (2007) recorded an incident in which feral hog damage killed a fragrant prickly-apple plant. Gopher tortoises may also bury small cacti at the mouth of burrows

(Bradley and Gann 2002). Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management even on protected lands remains an imminent, though moderate, threat. (USFWS, 2010)

**Stressor:** Climatic events (USFWS 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as freezes and hurricanes. Sea level rise may also threaten cacti on sites with low elevation, such as those at Canaveral National Seashore (Woodmansee et al. 2007). Woodmansee et al. (2007) suggested that freezing temperatures may have led to the extirpation of the species at one location in Brevard County. Although the species did well through the Category 1 hurricane in 2000 and the Category 2 and 3 storms in 2004 and 2005 (Bradley and Gann 2002; Woodmansee et al. 2007), specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction. Hurricanes have the potential to adversely affect fragrant prickly-apple populations in other ways. High winds can bring surrounding vegetation crashing down on top of individual cacti, injuring or killing them. Bradley and Hines (2007) found that mortality rates more than tripled at SPSP as a result of hurricane impacts. One colony that was particularly affected was located beneath invasive white cypress pine trees which were not equipped to handle hurricane winds and either fell or lost numerous branches that crushed the cacti below (Bradley and Hines 2007). However, hurricanes also open hammock canopies, allowing light to penetrate and stimulating flowering activity, thus providing conditions that may be favorable to cactus regeneration (Bradley and Gann 2002; Woodmansee et al. 2007). (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
Not defined; 1999 Recovery Plan provided only "stabilization" criteria. (USFWS, 1999)

Recovery Priority Number: 3

**Delisting Criteria:**
1. When at least 15 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. When populations (as defined in criterion 1) in coastal sand pine scrub habitat are distributed across the historical range of the species. (Factors A and E) (USFWS, 2019)

3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed (e.g., appropriate burn intervals) such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, B, D, and E) (USFWS, 2019)

**Recovery Actions:**

- 1. Determine distribution of C. e. var. fragrans. Known C. e. var. fragrans populations occuron well-drained soils indicative of xeric upland plant communities. Much of the xeric upland habitat of Indian River and St. Lucie counties remains botanically unsurveyed and threatened with destruction. Efforts to survey and assess the xeric vegetative communities for C. e. var.fragrans are needed to ensure the survival of this species. (USFWS, 1999)
- 2. Protect and enhance existing populations. Of the three populations known, one occurs on private land in residential areas and two occur in Florida's Savannas State Preserve. Additional protection at each of these sites is needed. (USFWS, 199)
- 3. Conduct research on the biology of C. e. var. fragrans. Much of the basic biology and ecology of this species remains poorly understood. If we are to effectively recover the species, more specific biological information will be needed. (USFWS, 1999)
- 4. Monitor C. e. var. fragrans populations. Maintain an inventory of naturally reproducing populations to help determine habitat characteristics and natural environmental changes affecting C. e. var. fragrans. (USFWS, 1999)
- 5. Provide public information about the fragrant prickly-apple cactus. It is important, and perhaps crucial, to the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and landowners be appropriately informed about this species. Informing the conservation organizations such as the Cactus and Succulent Society is appropriate, but care is needed to avoid unnecessarily revealing localities and to avoid stimulating demand for the species. Efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of C. e. var. fragrans and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- 6. Establish delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFS, 1999)
- Habitat-level Recovery Actions: - Protect, manage and enhance habitat. None of the habitat for C. e. var. fragrans on private land is secure at this time. Efforts to protect these sites are essential since many of the remaining plants occur on private land. - Monitor habitat and ecological processes. Little is known regarding response of C. e. var. fragrans to land management actions used in coastal xeric communities. The effects of fire, vegetative cutting, or other measures must be monitored to determine biological and ecological consequences. - Continue public information efforts about xeric vegetative communities and their unique biota. Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about xeric plant communities to the public. (USFWS, 1999)
- Surveys: • Continue monitoring the SPSP and Volusia County populations on an annual basis and after stochastic events, such as fires. 13 • Conduct additional surveys on other parts of Hutchinson Island South in St. Lucie County, Sebastian Inlet State Park in Brevard and Indian River Counties, spoil islands in Indian River and St. Lucie Counties, Pelican Island National Wildlife Refuge and the southern end of Pine Island in Indian River County, and other potential locations within the historic range. • Re-survey the Pine Island location to confirm the identity of the plant in question. (USFWS, 2010)
- Management: • Continue management actions to remove invasive species with particular care in using mechanical means and herbicide application that may damage cacti; control public access to these areas to avoid human disturbance and to improve habitat conditions.

• Continue application of prescribed fire to habitats that support the species while maximizing the number of burn units rather than applying fire to large expanses of habitat. • Consider reducing the canopy in areas where cacti are impacted by too much shade. • Restore coastal hammocks along the eastern slope of the Atlantic Coastal Ridge. • Where unable to restore coastal hammocks, maintain the threeawn (Aristida gyrans)/ Sabal palm (Sabal palmetto) habitat that fragrant prickly-apple now occupies for the long-term existence of the species. • Control public access and eliminate dumping in areas where fragrant prickly-apple occurs. • Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species. • Evaluate the feasibility of acquiring private property in Brevard County for reintroduction of the species, identify suitable habitat for additional reintroduction sites in protected areas, and establish reintroduced populations. • Increase the genetic diversity of the species at existing and reintroduced locations. (USFWS, 2010)

- Research: • Conduct demographic studies using a metapopulation approach to understand spatial and temporal variation. Incorporate surveys to evaluate flower and fruit production. • Develop a model to evaluate long-term population growth in relationship to microhabitat conditions (i.e., shade, partial shade, and sun). • Develop mechanisms to improve seedling survival and continue to study seed germination to determine habitat preferences of the species. Evaluate the role of nurse plants that provide shade in the early development of seedlings. • Conduct research on recruitment, mortality, seed bank characteristics, and soil moisture. • Conduct parallel studies on the other two similar cacti in Florida, Simpson's pricklyapple and Aboriginal pricklyapple (Harrisia aboriginum), to gain additional insight into fragrant prickly-apple biology and to delineate these species. • Continue genetic research and appropriately apply these results to listing status of all Harrisia species in Florida. • Conduct a population-level genetic study using microsatellite markers to determine genetic variation within the species and gene flow in and among sites and to better understand the reproductive mode at low population densities. • Conduct research on the response of fragrant prickly-apple to fire and fire prescriptions necessary to benefit the species. • Identify pollinators and evaluate impacts to insect pollinators from aerial mosquito spraying. • Continue propagation efforts and collect germ plasm from the remaining sites not currently represented in the CPC's National Collection of Endangered Plants, primarily from the Volusia County population. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2010)
- Other: • Pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage habitat for ecosystem health and listed species. • Acquire private inholdings within the SPSP when willing sellers are identified. • Consider acquiring the Pine Island tract in Indian River County and determine the status of Fairchild Tropical Botanic Garden's ex situ population of plants from this site. • Promote partnerships to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Consider nomenclatural changes to officially designate the name of the fragrant pricklyapple as Harrisia fragrans. • Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize 5- and 10-year goals. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Continue management actions to remove invasive species at CNS, ACNWR, SPSP with particular care when using mechanical means and herbicide application that may damage cacti. • Control public access to populations on public lands to avoid human disturbance. • Continue application of prescribed fire to pyric habitats that support the species at SPSP and ACNWR while using protection measures (e.g., clearing leaf litter away from cacti, creating more burn units for small, patchy fires, etc.) to prevent harming these populations. • Reduce the canopy cover only when the cacti become impacted by too much shade, but leave enough vegetation to protect from desiccation. • Move fallen trees and woody debris away from fragrant prickly-apples to reduce chances of termite damage. • Restore coastal hammocks along the Atlantic Coastal Ridge for potential introduction sites. • Identify suitable areas of protected xeric and coastal hammock for introductions and establish new populations. • Focus conservation efforts (habitat management, augmentations, etc.) on small populations (CNS, ACNWR, Central SPSP) to reduce inbreeding depression and preserve the genetic diversity of the species. • Consider translocating the CNS population to a higher elevation to prevent further decline due to sea level rise and storm surge. • Continue propagation efforts and collect and bank germplasm and seed from the remaining sites not currently represented in the CPC's National Collection of Endangered Plants, primarily from the Volusia, Brevard, and Indian River County populations. • Acquire private inholdings within the SPSP when willing sellers are identified. • Acquire the Pine Island tract in Indian River County if the species is still present. • Work with private land owner(s) (Roseland population) and Indian River County staff to translocate individuals in undeveloped lots as that portion of the property is developed. Monitoring/Research Activities • Conduct a scientific review (e.g., SSA) of the new entity and evaluate its listed status under provisions of the ESA. • Continue monitoring the SPSP and CNS populations on an annual basis and after stochastic events, such as freezes, fires, and hurricanes. • Begin annual monitoring efforts for the ACNWR, Roseland, and HBOI populations to assess status and trends. • Re-survey the Pine Island (Indian River County) location to confirm the identity and status of the plant in question. • Conduct additional surveys on other parts of the barrier and spoil islands along Brevard, Indian River, and St. Lucie counties, as well as other potential locations on the mainland within the historical range. • Conduct surveys in suitable habitat within Martin, Palm Beach, and Broward counties to look for fragrant prickly-apple populations that may occur between the fragrant pricklyapple and populations formerly known as Simpson's prickly-apple. • Assess the status of the populations formerly known as Simpson's prickly-apple in Miami-Dade and Monroe counties in preparation for evaluating the status of and threats to the synonymized species. • Conduct research on the response of fragrant prickly-apple to fire and fire prescriptions necessary to benefit the species. • Identify pollinators and evaluate impacts to insect pollinators from aerial mosquito spraying. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. • Increase outreach efforts to raise awareness of this native species, the natural scrub, xeric hammock, coastal strand, and coastal hammock habitats, and the work needed to recover the species. (USFWS, 2021)

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# SPECIES ACCOUNT: *Chamaesyce deltoidea pinetorum* (Pineland sandmat)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

**Physical Description**

Chamaesyce deltoidea ssp. pinetorum is an ascending to erect perennial herb. The stems are hairy and often reddish. The leaf blades range from kidney-shaped or triangle-shaped and elliptic to oval. The fruit is a 2-mm broad, pubescent capsule. The seeds are 1 mm long, transversely wrinkled, and yellowish in color. Fruit production is year-round, with a peak in the fall. (USFWS, 2017)

**Taxonomy**

Chamaesyce deltoidea ssp. pinetorum was first described by Small in 1905, based on specimens collected in eastern Miami-Dade County. Initially, Small referred to these specimens as C. pinetorum but recognized that it was closely related to Chamaesyce deltoidea. Herndon (1993, included C. pinetorum within the C. deltoidea complex, which is composed of three other taxa, two occurring farther north on the Miami Rock Ridge, and one occurring on Big Pine Key in the lower Florida Keys (Monroe County). The three taxa on the Miami Rock Ridge have distinct, but adjacent, ranges. Subsequently, Herndon (1993) has placed all four taxa at the same taxonomic level, treating each as a distinct subspecies under Chamaesyce deltoidea (C. deltoidea ssp. pinetorum, C. deltoidea ssp. serpyllum, C. deltoidea ssp. adhaerens, and C. deltoidea ssp. deltoidea). Chamaesyce deltoidea ssp. deltoidea and C. deltoidea ssp. adhaerens occur north of known C. deltoidea ssp. pinetorum populations, while Chamaesyce deltoidea ssp. serpyllum is endemic to Big Pine Key. Wunderlin and Hansen (2016) follow Herndon's treatment in using C. deltoidea ssp. pinetorum. Some modern authors place the genus Chamaesyce into the genus Euphorbia sensu lato. If placed into the genus Euphorbia, the correct name of pineland sandmat is Euphorbia deltoidea ssp. pinetorum. The online Atlas of Florida Vascular Plants uses the name Chamaesyce deltoidea ssp. pinetorum (Small) Herndon (Wunderlin and Hansen 2016, p. 1). NatureServe (2016, p. 1) and FDACS (Coile and Garland 2003, p. 11) indicate that C. deltoidea ssp. pinetorum is accepted. However, the Integrated Taxonomic Information System (ITIS 2016, p. 1) accepts Euphorbia deltoidea ssp. pinetorum as the scientific name for the subspecies (Gann 2015, p. 168). We have carefully reviewed all taxonomic data to determine that C. deltoidea ssp. pinetorum is a valid taxon. (USFWS, 2017)

**Historical Range**

Chamaesyce deltoidea ssp. pinetorum occurred historically only with the southern portion of the Miami Rock Ridge, from Homestead to the Long Pine Key region of Everglades National Park, a range of approximately 42 mi (67.6 km). (USFWS, 2017)

**Current Range**

The current range of Chamaesyce deltoidea ssp. pinetorum is similar to the historical range, although 98 percent of the pine rocklands (the species' only habitat) outside of the Everglades National Park has been lost to development. (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2017)

**Lifespan**

Adult: Somewhat long-lived; 88 percent of plants survived more than 3 years. Extensive root system (USFWS, 2017)

**Dependency on Other Individuals or Species**

Adult: Pollinators may include bees, flies, ants, and wasps (USFWS, 2017)

**Breeding Season**

Adult: year-round

**Other Reproductive Information**

Adult: This species is known to flower and fruit year round. Peaks in fruiting for C. deltoidea ssp. pinetorum occur in the fall and are stimulated by fire. (USFWS, 2017)

**Reproduction Narrative**

Adult: Reproduction is sexual, but little is known about the reproductive biology and ecology of the subspecies. Some of the plants recorded as dead during surveys may have instead been in a cryptic phase . Pollinators are unknown; some other species of Chamaesyce are completely reliant on insects for pollination and seed production, while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps. (USFWS, 2017)

**Habitat Type**

Adult: Pine rockland in pockets of clayey marl or on oolitic limestone

**Dependencies on Specific Environmental Elements**

Adult: Fire is an important element in maintaining the pine rockland habitat.

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2017)

**Tolerance Ranges/Thresholds**

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

**Habitat Narrative**

Adult: Chamaesyce deltoidea ssp. pinetorum occurs in pine rocklands. Pine rocklands are maintained by regular fire, and are prone to annual flooding for several months during the wet season. However, C. deltoidea ssp. pinetorum generally occurs in higher elevation pine rocklands at Long Pine Key in Everglades National Park, in areas rarely subject to flooding. See detailed description of Pine Rockland habitat in Additional Habitat Information (USFWS, 2017)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal is unknown for Chamaesyce deltoidea ssp. pinetorum; however, many seed capsules in similar Chamaesyce species are explosively dehiscent, a form of dispersal that flings seeds far from the parent plant. Chamaesyce deltoidea ssp. pinetorum is thought to have a similar, but reduced, level of dispersal (USFWS, 2017)

***Population Information and Trends***

**Number of Populations:**

3 extant populations (2 wild, 1 reintroduced) (USFWS, 2023)

**Population Size:**

>313,000 (USFWS, 2023)

**Population Narrative:**

The total population size of Chamaesyce deltoidea ssp. pinetorum is estimated to be 14,500-146,000 individuals, with the majority of the population occurring on Long Pine Key. However, while Chamaesyce deltoidea ssp. pinetorum is most abundant within Everglades National Park, pine rockland fragments outside of the Everglades represent about half the subspecies' extant range. (USFWS, 2017). Though it was historically known from five islands (No Name Key, Big Pine Key, Ramrod Key, Cudjoe Key, and Lower Sugarloaf Key), only two populations were extant at the time of listing (Big Pine Key and Cudjoe Key; Service 2016). The Cudjoe Key population was not found during recent surveys despite habitat remaining in the area (Lange 2022) and is now considered potentially extirpated since seeds may persist in the soil seed bank for up to three years (Liu and Menges 2005). A translocation of plants and seeds sourced from Big Pine Key were used to reestablish a population on No Name Key in 2019 (Lange et al. 2019; Cuni et al. 2020; Figure 1). The species was extirpated from this area due to lack of habitat management, but restoration with mechanical treatment and prescribed fire occurred prior to reintroduction (Lange et al. 2019). In 2019, 48 individuals were transplanted to No Name Key (Cuni et al. 2020). Within a year after transplanting, over 300 first generation seedlings had recruited, and 220 seedlings were documented three years after transplanting (Fairchild unpublished data). Also in 2019, 720 seeds were sown in 36 seed plots at No Name Key (Cuni et al. 2020). One and half years after sowing, average emergence rates ranged from 31 to 53 percent and average survival rates ranged from 24 to 48 percent (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as

remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands.

**Stressor:** Inadequacy of Existing Regulatory Mechanisms
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

**Stressor:** Other Natural or Manmade Factors Affecting Its Continued Existence
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
Not defined.

Recovery Priority Number: 9

**Delisting Criteria:**
Not defined.

**Recovery Actions:**
- Not defined.
- Conserve pine rocklands and suitable habitat through purchase or conservation easements (Wendelberger 2003, p. 182).
- Remove exotic plants or hardwoods. Use manual labor, herbicides, and prescribed fire, and once cleared, use proper management to reduce costs of control and to maintain the site free of exotics (Bradley and Gann 1999, p 26.). Control seed sources in small, fragmented areas surrounded by urban development (Bradley and Gann 1999, p. 26).
- Implement regular, prescribed burns to create or maintain suitable habitat conditions. In general, a mosaic of burns should be used, and the recommended burning regime is 3 to 7 years with summer burns generally preferred to winter burns (Bradley and Gann 1999, p. 26). Where fire has been suppressed for long periods of time, reintroduce fire in a step-wise manner (Bradley and Gann 1999, p. 26; Wendelberger 2003, p. 182). Include a monitoring program to determine effectiveness of the fire prescription (Bradley and Gann 1999, p. 26).
- Monitor and manage pine rockland fragments in Miami-Dade County.
- Continue monitoring rare plants at Long Pine Key (Gann et al. 2006, p. 2). It is important to determine effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes.
- Resurvey known locations and compare those data with current location data to better understand the stability and size of the population (Wendelberger 2003, p. 183; Maschinski et al. 2005, p. 163).
- Consider ex situ collections (Maschinski et al. 2005, p. 163).
- Assess the need for studies to determine current level of genetic variation remaining in extant occurrences.
- Assess the need to augment the population (Wendelberger 2003, p. 183).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIVITIES This species does not have a final recovery plan. While completing this status review, we have identified the following potential recovery activities which are included below. Recovery Activities • Conduct or continue to conduct habitat maintenance or restoration at occupied areas, including removal of native hardwoods and non-native invasive plants and prescribed burns every 5-7 years. • Protect parcels on Big Pine Key that are occupied by the species. • Continue monitoring the reintroduction on No Name Key and augment as needed, until population is established. • Develop a translocation/reintroduction plan to identify other potential recipient sites for reintroducing or establishing populations. Any future introductions in the Lower Keys should include deer exclusions to protect plants, at least during the establishment phase, and potentially in the longer-term as well. Monitoring and Research Activities • Conduct regular monitoring and assessments of the status of the Big Pine Key population. •

Conduct research on viability of seeds in long-term cold storage to determine storage lifespan and the rate at which stores should be replenished. • Collect and bank wild seeds at an appropriate ex situ facility at least once per decade, or more often if indicated by results of research on viability in storage. • Identify the best management regimes for Big Pine partridge pea along roadsides. • Research the effects of Key deer browsing on Big Pine partridge pea abundance and fitness. • Continue research on the effects of mosquito spraying on Big Pine partridge pea fruit set and plant fitness. Outreach Activities • Increase public education and outreach about native plants and habitats in the Lower Keys community, involve local schools and residents in habitat conservation and restoration efforts geared toward Big Pine partridge pea and other rare species and habitats. • Conduct public outreach on Big Pine Key and No Name Key aimed at improving residents' opinions about prescribed fire and its ecological importance (noting that poststorm-surge recovery of the Big Pine partridge pea is greater in areas that have recently burned) (USFWS, 2023).

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# SPECIES ACCOUNT: *Chamaesyce deltoidea ssp. deltoidea* (Deltoid spurge)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/19/1985; Southeast Region (R4)

**Physical Description**

Chamaesyce deltoidea ssp. deltoidea is a small, monoecious, prostrate to decumbent herb occurring in mats over exposed limestone. The stems are terete (circular although slightly oblong) in cross section, brown, and 0.3 to 0.6 mm in diameter. The leaves are smooth above to slightly hairy below, with an obtuse apex, cordate base, margins entire; stipules laciniate, brown to reddish brown with light tips, and smooth. The inflorescence is found singly, in leaf axils, with a short peduncle (1 mm long). The cyathium is 1.2 mm long, 1.0 mm wide and smooth (glabrous). It is green and ovate in shape with four glands and minute appendages. The fruit is a capsule, 1.0 mm long and 1.0 mm wide, and completely glabrous. The pedicel is also glabrous. It is fully exerted at maturity. There are three seeds, 1.0 mm long and 0.5 mm wide, ovate in shape and glabrous. The seeds are laterally four-ridged and yellowish-white (Remus 1979). The leaves and stems of the subspecies Chamaesyce deltoidea ssp. adhaerens are appressed to the ground surface and the plants form mats. In some cases the stems will ascend and form tufts (Herndon 1993). The inflorescence is solitary, terminal, pedunculate (1.5 mm long), and glabrous proximally to pilose distally. The main distinction between the two subspecies is their pubescence. The pubescence of the subspecies C. deltoidea ssp. adhaerens is appressed on the leaves and on the stems it is spreading or appressed (Herndon 1993). The pubescence for C. deltoidea ssp. deltoidea is sparse, appressed on the leaves and the stems are glabrous or thinly pubescent (Herndon 1993). (USFWS, 1999)

**Taxonomy**

Deltoid spurge was first described as Euphorbia deltoidea by Engelman (Chapman 1883). In 1903, Small transferred the species to the genus Chamaesyce, a natural genus distinguished from Euphorbia by having the main stem abortive just above the cotyledons, making the aerial portion of Chamaesyce homologous to the inflorescence of Euphorbia subgenus Esula (Webster 1967). Burch (1966) treated C. deltoidea as a complex of three taxa endemic to South Florida: C. deltoidea, C. adhaerens Small, and C. serphyllum Small, treating deltoid spurge as C. deltoidea (Engelman ex Chapman) Small subsp. deltoidea var. deltoidea without comment. In Herndon's (1993) revision of the C. deltoidea complex, he recognized four subspecies endemic to South Florida: ssp. deltoidea, ssp. adhaerens, ssp. pinetorum, and ssp. serphyllum. The taxonomy of this complex is difficult and some follow Burch's 1966 treatment and others follow Herndon's 1993 treatment. The final rule as listed in the Federal Register applies to the taxa deltoidea and adhaerens, which are restricted to Miami-Dade County, Florida. According to this, all members of the C. deltoidea complex that are restricted to Miami-Dade County are considered endangered species by the FWS. For purposes of clarity, Herndon's treatment will be used for this recovery plan. Synonyms: Euphorbia deltoidea Engelman ex Chapman; Chamaesyce deltoidea (Engelman ex Chapman) Small ssp. deltoidea var. deltoidea; Chamaesyce adhaerens Small; Chamaesyce deltoidea (Engelm. ex Chapman) ssp. deltoidea var. adhaerens (Small) Burch. (USFWS, 1999)

**Historical Range**

In Florida, endemic that was historically known to occur in pine rocklands from the Goulds area north to the center of the city of Miami (USFWS, 1999)

**Current Range**

In Florida, from south Miami to the Homstead area (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowers from April through November, peaking in July. (USFWS, 1999)

**Reproduction Narrative**

Adult: Studies into the life history of the deltoid spurge have only recently begun and little is known about its reproduction. It is a perennial that flowers from April through November, peaking in July. Its extensive root system gives evidence that it is a long-lived plant (DERM 1994). The reproductive ecology in Chamaesyce has been poorly studied but it is known to be highly variable (Ehrenfeld 1976, 1979; Webster 1967). Some species are completely reliant on insects for pollination and seed production, while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979). Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988). (USFWS, 1999)

**Habitat Type**

Adult: Pine rocklands (USFWS, 1999)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: The deltoid spurge tends to occur in areas with an open shrub canopy, exposed limestone (oolite), and minimal litter (pine needles, leaves, and other organic materials). It is most often found growing at the edges of sand pockets with plants growing both in sand (sometimes in association with the endangered Polygala smallii) and on oolitic limestone. The soils in which it grows are classified as Opalocka-Rock Outcrop soils. The subspecies C. deltoidea ssp. adhaerens occurs in fine, reddish sandy loam over limestone. Dense colonies are sometimes found in pinelands that have undergone a slight mechanical disturbance, where little or no topsoil is formed and where productivity is low. The shrub canopy in this disturbed habitat is often poorly developed providing high light levels and low organic litter accumulation rates. The pine rocklands are often considered a fire subclimax, and are maintained with periodic fires (3 to 7 years). These periodic fires keep the shrub canopy down and eliminate the litter accumulations. (USFWS, 1999)

### *Dispersal/Migration*

**Dispersal/Migration Narrative**

Adult: Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988).

### *Population Information and Trends*

**Population Trends:**

Unknown

**Number of Populations:**

15 sites (USFWS, 2023)

**Population Size:**

~16,000 to 20,000 individuals (USFWS, 2019)

**Population Narrative:**

The current known populations of deltoid spurge include 13 public and 2 private sites (Table 1). The largest populations of this subspecies were recorded at Zoo Miami with 10,000 plants, followed by Larry and Penny Thompson Park with 5,300 plants and 808 plants at Ludlam Pineland (Appendix A). These three locations account for over 80 percent of the total known density of the deltoid spurge plant population. Eight populations have been extirpated due to habitat fragmentation, degradation, and fire suppression (Service 2019). Seven of the extirpated populations occurred on public conservation lands. The Bill Sadowski Park population had three plants in a 2016 population estimate (Bradley, pers. comm 2010, Lange pers comm 2017, and Possley pers. comm 2017a). However, a Fairchild survey in 2023 could not find any deltoid spurge at this location, and it is now presumed extirpated (Possley pers. comm 2023). Fairchild reintroduced seeds in one known extirpated location (Trinity Pineland) in summer 2023 (Possley, pers comm 2023). It is too early at the time of this review to determine successful reestablishment, and therefore we continue to assume extirpation at this location (USFWS, 2023).

### *Threats and Stressors*

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

**Stressor:** Nonnative invasive plants

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

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

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

**Stressor:** Climate Change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change will impact pine rockland habitat through sea level rise, variability in precipitation and temperature that can cause shifts in vegetation types, increases in freezing conditions, and increase in intensity and frequency of storm and fire events (Wanless et al. 2008, Wear and Greis 2012, Intergovernmental Panel on Climate Change 2021, Runkle et al. 2022). By 2100, direct losses of pine rockland plant populations are expected due to habitat loss and successions caused by sea level rise (Vargas-Moreno and Flaxman 2010, Zhang et al. 2011, Park and Sweet 2015, Rahmstorf et al. 2015, University of Florida Geoplan Center 2015, Sweet et al.

2022). Additionally, changes in regional hydrology may have impacts on the pine rockland habitats. Increased and longer-duration hydroperiods in the areas inhabited by endangered pine rockland species may lead to a reduction in the amount of suitable habitat, a potential reduction in the area occupied, and a reduction in the number of deltoid spurge individuals found (USFWS, 2023).

**Stressor:** land modification for development (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Extensive land modification for development throughout the species historic range has led to habitat loss, fragmentation, and alterations that render the habitat unsuitable for deltoid spurge (Factor A). Due to land modifications of pine rocklands, suitable habitat for deltoid spurge outside of protected areas is limited, severely fragmented, isolated, and degraded. These characteristics contribute to the species low resiliency (ability to withstand stochastic events), low redundancy (ability to recover from catastrophic events), and low representation (low genetic dispersal) (USFWS, 2023)

***Recovery***

**Reclassification Criteria:**
1. Enough demographic data are available to determine the appropriate numbers of self sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 2010)

2. When these populations, within the historic range of deltoid spurge are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression (USFWS, 2010)

3. When these sites are managed to maintain the pine rocklands to support deltoid spurge (USFWS, 2010)

4. When monitoring programs demonstrate that populations of deltoid spurge on these sites support sufficient populations sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 2010)

Recovery Priority Number: 6C

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

2. A network of 6 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

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

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

**Recovery Actions:**

- Conduct surveys to determine distribution of pine rockland plants. Pine rockland plants were thoroughly surveyed in Miami-Dade County; however, the status of C. deltoidea is not known over its entire range. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of pine rockland plants that additional populations not be lost. (USFWS, 1999)
- Collect biological information important to species recovery. Additional information on the ecology and life history of pine rockland plants needs to be collected. The size and viability of known populations of C. deltoidea needs to be evaluated. (USFWS, 1999)
- Monitor C. deltoidea populations. Use existing standardized monitoring protocols developed by the Florida Natural Areas Inventory to record baseline data regarding the biology and ecology of C. deltoidea. Determine the effects of management actions on C. deltoidea. Initiate quarterly monitoring programs. (USFWS, 1999)
- Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. Future modifications to this program may include tri-lingual distribution (Spanish, English, and Haitian Creole). (USFWS, 1999)
- Habitat-Level Recovery Actions: Continue to protect pine rockland plant habitat in order to prevent degradation. Restore areas to suitable habitat. Conduct habitat-related research. (USFWS, 1999)
- Habitat degradation continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding (Service 2006).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1999) and the Recovery Plan amendment (Service 2019). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Implement, continue, or increase habitat restoration efforts (exotic species removal and prescribed burns/similar disturbance) where deltoid spurge is located (recovery criteria 4). • Identify and pursue conservation agreements or other agreements that protect pine rocklands and deltoid spurge populations (recovery criteria 2 and 3). • Identify and restore patches of pine rocklands that have been historically occupied by deltoid spurge (recovery criteria 1). • Additional partnerships should be promoted to share information, conduct collaborative research, and provide land managers and interested public with information (recovery criteria 1 & 4). • Develop a translocation/reintroduction plan to identify potential recipient sites for reintroducing or establishment of populations within the historical range (recovery criteria 2). Monitoring and Research Activities • Evaluate ‘unknown’ population locations to determine number of individuals or extirpation of the species at those locations (recovery criteria 1). • Monitor extant populations annually and document individual number estimates to determine population trends (recovery criteria 1). • Survey areas that have suitable habitat for the species to identify new populations and/or translocation sites (recovery criteria 2). • Research ex situ propagation and seed bank viability (recovery criteria 2). • Examine the demography and reproductive biology of the deltoid spurge to determine population trends and growth and establishment rates (recovery criteria 1). • Study individual populations to determine genetic diversity (recovery criteria 1). • Research management techniques and impacts particularly with prescribed fire impacts on the biology and life history of deltoid spurge (recovery criteria 4). Outreach Activities • Increase public awareness and appreciation for native plants and habitats. • Attend public events when appropriate to improve the communities understanding of management techniques and policies, such as prescribed fire, in pine rockland habitats (USFWS, 2023).

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# SPECIES ACCOUNT: *Chamaesyce garberi* (Garber's spurge)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 7/18/1985; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A prostrate herb with pubescent stems. Leaves are ovate and 4-9 mm long. Flowers are conspicuous. (NatureServe, 2015)

**Taxonomy**

The treatment of the clade to which Garber's spurge belongs has historically been a subject of disagreement among botanical authorities. While many (Burch 1965; Hassall 1977; Herndon 1993) have recognized Chamaesyce as a distinct and separate genus within the Euphorbiaceae family based on morphological characters, more recent molecular phylogenetic evidence suggests that this taxon is more appropriately treated as a subgenus within Euphorbia (Yang and Berry 2011; Horn et al. 2012). The Integrated Taxonomic System (2022), the Flora of North America (2022), the Atlas of Florida Plants (Wunderlin et al. 2022), and the Flora of the Southeastern United States (Weakley 2022) all accept this treatment. This represents a change in nomenclature for the species compared to its listing name in 1985 from Chamaesyce garberi to Euphorbia garberi but does not change the circumscription of the species or its status as a distinct, threatened taxon (USFWS, 2022).

**Historical Range**

Garber's spurge is endemic to South Florida (USFWS, 1999). It formerly occurred in Dade and Monroe counties, Florida, from Miami to the lower Florida Keys. Has disappeared from much of its historical range. (NatureServe, 2015)

**Current Range**

The current range of Garber's spurge has decreased compared to its historic range due to a few extirpations on the peripheries. Notably, the species was previously known to occur in Collier County (although from only one collection) but was not found there or in surrounding suitable habitat in more recent surveys and is presumed extirpated at this location (Green at al. 2008). Additionally, in MiamiDade County the species had formerly occurred from the vicinity of the City of Miami south of the Miami River to the Cutler area. However, three populations are now extirpated and only two Garber's spurge populations are known to be extant in Miami-Dade County. The Everglades Garber's spurge populations at Long Pine Key (Pine Blocks B and C) and Northwest Cape Sable were estimated to have over 1,000,000 individuals each in 2007, though the latter has declined dramatically since this time (Lange et al. 2020) and the former has not been resurveyed. In the Keys, Garber's spurge still occurs throughout its entire historical range since populations are extant at the western and eastern boundaries, from Key Largo to the Marquesas Keys. Extant populations are known from at least 21 islands in the Florida Keys though this range characterization may be an overestimation considering that most populations have not been revisited in 10-15 years and some of the smaller populations would be especially vulnerable to stochastic change and extirpation. Twelve populations in the Keys have been extirpated from 9 islands (5 of which had no other Garber's spurge populations) (Green et al. 2008; FNAI 2022). Although these extirpations don't represent a decrease in range for Garber's spurge (i.e., they occur within the interior of its range), they do represent a decrease in area of occupancy and an increase in fragmentation. See Figure 1 for a map of both extant and extirpated populations throughout this species' range (USFWS, 2022).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Terrestrial, palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Herbaceous wetland, barrens, forest, grassland, dune, shrubland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fires (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Dry, sandy soil in ecotones between hammocks and pinelands or coastal hammocks and sea-oats dunes. Requires periodic burning or is shaded out as succession occurs (NatureServe, 2015). Garber's spurge occurs at low elevations either on thin sandy soils composed largely of Pamlico sands or directly on limestone. It is found in a variety of open to moderately shaded habitat types. In pine rocklands, it grows out of crevices in oolitic limestone. On Cape Sable, Everglades NP, it has been reported from hammock edges, open grassy prairies, and backdune swales. In the Florida Keys, it grows on semi-exposed limestone shores, open calcareous salt flats, pine rocklands, calcareous sands of beach ridges, and along disturbed roadsides. Soils are composed largely of Pamlico sands or directly on limestone.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (inferred from USFWS, 2007)

**Species Trends:**

Unknown (USFWS, 2007)

**Number of Populations:**

~31 (USFWS, 2022)

**Population Size:**

Unknown (NatureServe, 2015)

**Population Narrative:**

Garber’s spurge is estimated to occur in 31 populations in Monroe and MiamiDade Counties, though many of them (24) have not been surveyed for 10-15 years. The previous status review (Service 2007) reported 17 populations, but only two new populations have been discovered since then. The main difference in the number of populations is how they were grouped together in the previous review. Some islands in the Keys have more than one population, or clusters of plants more than 1.0 kilometers (0.62 miles) from other clusters (NatureServe 2020), but the previous review counted them as one population since they occurred on one island. Also, the previous review grouped all the Cape Sable populations into one instead of counting each Cape as a separate population. General population abundance, trends, and demography are unknown since no population has been monitored consistently on an annual or semi-annual basis to track this information. The current status of many populations of Garber’s spurge is also unknown due to a lack of surveys since Green’s extensive range-wide status survey in 2006-2007. Population sizes for most occurrences are still based on Green’s work and presume that these populations are still extant, though updated surveys are needed to confirm this. Green’s report revealed that Garber’s spurge population sizes vary widely, ranging from over 1,000,000 plants in two locations (at the time) to less than 10 plants at other sites (Green et al. 2008). For populations that have been monitored more recently, only two are estimated to be stable, one may be increasing, and two are likely decreasing (Table 1). Twentyfour are presumed extant with an unknown trend due to lack of recent surveys. Approximately 16 have been extirpated and 2 have an unknown status (no plants observed in 2006-2007 surveys but had potential to re-appear) (Green et al. 2008; FNAI 2022). Only two populations occur in Miami-Dade County (the Long Pine Key area of ENP and CDE). In Monroe County extant or presumed extant Garber’s spurge populations are reported from the mainland in the Cape Sable area of ENP, as well as 21 islands in the Florida Keys (Table 1). In mainland Monroe County, the species was historically known from all three Capes on Cape Sable (ENP), representing three distinct populations (though grouped as one population in the previous review [Service 2007]). In 2006, it was found on only the Middle and Northwest Capes (Green et al. 2008). Although it was thought to be extirpated in the previous status review (Service 2007), the population on East Cape was only temporarily eliminated by hurricane damage incurred in 2005. In 2013, a small population of Garber’s spurge was discovered on East Cape Sable by the ENP botanist, but it is unknown if this is the same location where it was documented in 2005 (Gann 2015).   One of the largest documented populations was that in Northwest Cape Sable where over 1,000,000 plants were estimated to occur in 2007 (Green et al. 2008; Lange 2017). This is the only population where a thorough, updated survey has taken place which showed an approximate 86 percent decrease in the number of plants observed along transects used in both the 2007 and 2017 surveys (Lange et al. 2020). Extrapolated out to the whole population, this means that there may be about 90,000 plants remaining at this location. While this still represents one of the largest and most robust populations of this species, the rapid and steep decline in abundance is still great cause for concern. The decline is most likely due to a lack of fire on the landscape, as evidenced by a significant increase in tree and shrub cover in what should be open habitat (Lange et al. 2020). Within Long Pine Key there may still be over 1,000,000 plants (Green et al. 2008; Lange 2017), but an updated survey is needed. The sub-populations at this location have apparently undergone a large expansion since previous reports did not indicate large population numbers (Bradley 2007; Green et al. 2008). The surveys in 2006 estimated 600-700 individuals in Deer Hammock (Pine Block A) and approximately 1,250,000 in Pine Blocks B and C (Green et al. 2008). Because of the number of plants, geographic size, favorable management activities at ENP, and, for the interior Long Pine Key site - distance from the coast, the populations within ENP may be the most secure of the known extant Garber's spurge populations. However, careful surveys have not been completed here since 2006 and only continued presence of the populations has been noted (Sadle 2022). At the CDE, Miami-Dade County's Department of Environmental Resource Management (DERM; 1993) reported a population size of 250-500 plants based on four days of searches specifically for this species. Herndon (2002) estimated a population size of 600-6,000 plants. In contrast, Possley (2007) suspected that only 100-200 plants were present in 2004, but estimated approximately 50-100 plants at this site in 2017 and 2021 (Possley 2017, 2022a), but emphasized the important caveat that dedicated species-specific surveys have not been completed for Garber's spurge in many years and this is only an approximate number based on site visits for monitoring of other species. The largest populations occurring in the Keys are located on Vaca, Bahia Honda, Big Torch, Woman, and Marquesas Keys (Table 1), but updated population estimates were not available for this review. Similar to the largest mainland populations, these mostly occur in protected areas or on remote islands. Many smaller populations occur throughout the Keys and some of them were observed to still have plants within the last 6 years (Long Key State Park, No Name Key, Big Munson, and Boca Grande), but have not been thoroughly surveyed since 2006-2007. Additional populations may occur in the Keys on private properties with fragments of suitable habitat where botanists have not yet been able to obtain access. For example, Boot Key is mostly privately owned and was noted for having suitable habitat, but permission was not granted to conduct a thorough survey of the island (Green et al. 2008). However, plants were found along an accessible right-of-way and so it is entirely plausible that additional Garber's spurge exists within the privately-owned areas. Other islands with intact habitat may harbor additional populations as well (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Development is a concern for this species mainly in the Keys. Without intervention, areas on private land that may contain Garber's spurge will most likely be altered. Some sites are threatened by fire suppression and/or exotic plants that have been managed insufficiently (USFWS, 2007).

**Stressor:** Key deer (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Dooley (1975) reported Garber's spurge as a food plant of Key deer. The Key deer population increased 240% between 1971 and 2001 (Lopez et al. 2004), and this increase has probably had a significant impact on the vegetation in the deer's range (USFWS, 2007).

**Stressor:** Recreation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Populations on dunes have the potential to be threatened by trampling from beach goers (USFWS, 2007).

**Stressor:** Small population size (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because populations are very small, they are subject to extirpation as a result of human or natural stochastic events. Sea level rise may become a significant threat in coming decades. Populations typically occur at elevations less than 0.50 meters; recent estimates for sea level rise through 2100 range from 0.28 - 0.34 meters (Church and White 2006) (USFWS, 2007).

***Recovery***

**Reclassification Criteria:**
1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 95% probability of persistence for 100 years (USFWS, 2007).

2. When these populations within the historic range of Garber's spurge are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression (USFWS, 2007).

3. When these sites are managed to maintain the pine rocklands to support Garber's spurge (USFWS, 2007).

4. When monitoring programs demonstrate that populations of Garber's spurge on these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 2007).

Recovery Priority Number: 8

**Delisting Criteria:**
Not available

**Recovery Actions:**
- Determine the distribution of the species in South Florida (USFWS, 1999).
- Protect and enhance populations (USFWS, 1999).
- Conduct research on biology/ecology (USFWS, 1999).
- Monitor populations (USFWS, 1999).
- Inform and involve stakeholders and the general public in the recovery process (USFWS, 1999).
- Acquire privately owned properties where the species occurs, including coastal rock barrens on Long Key and Crawl Key (USFWS, 2007).
- Where present on roadsides, maintain an infrequent mowing regime to allow plants sufficient time to flower and disperse seeds. Do not plant turf grasses in or next to roadside

populations. Trim hardwoods from edges of population to prevent shading. Communicate these road maintenance guidelines with road maintenance crews (USFWS, 2007).

- Implement a prescribed fire program at the Deering Estate at Cutler with a fire return interval of 3 - 7 years (USFWS, 2007).
- Ensure that Monroe county regulators can identify Garber's spurge to ensure that developers pay proper mitigation fees when applying for building permits (USFWS, 2007).
- Continue or initiate exotic plat control at all sites where populations occur (USFWS, 2007).
- Initiate long-term monitoring of presence or population sizes of all populations, or at a minimum, at a subset which includes the geographic range of the species and a variety of habitat types (USFWS, 2007).
- Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, coastal habitats, and disturbed areas (USFWS, 2007).
- Reintroduce populations to stations where formerly present (USFWS, 2007).
- Conduct studies of coastal rock barren habitat to determine successional processes and management needs of the ecosystem (USFWS, 2007).
- Remove hardwoods from disturbed area where Garber's spurge occurs at Crocodile Lake National Wildlife Refuge, and use this population as a source of germplasm for reintroductions into natural habitats in the Key Largo area (USFWS, 2007).
- Conduct genetic studies to clarify relationships with C. porteriana, determine if patterns of morphological variation reported by Herndon (1993) are genetically based, and determine if inbreeding depression is occurring within any populations (USFWS, 2007).
- Develop population viability and risk assessments for all populations, based on monitoring and demographic studies (USFWS, 2007).
- Conduct seed bank studies to determine longevity of seed bank and viability under different conditions (USFWS, 2007).
- Study relationship of fire to population demography of Garber's spurge to determine potential impacts of sea level rise (USFWS, 2007).
- Search recently burned pine rocklands in the lower Florida Keys for Garber's spurge (USFWS, 2007).
- Study impacts of hurricanes on Garber's spurge populations in coastal habitats (USFWS, 2007).
- One recovery criteria that should be modified states that sites must be managed to maintain pine rocklands to support Garber's spurge. Because pine rockland is not the primary habitat for the species in much of its range, this criterion should be updated to additionally require that dunes, coastal grasslands, and coastal rock barrens be managed to support the species (USFWS, 2007).
- Determine if Key deer forage significantly on Garber's spurge (USFWS, 2007).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1999). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Implement prescribed fire at sites with Garber’s spurge where needed (ENP, CDE, NKDR). Consider manual hardwood removal/thinning if prescribed burning is not possible based on landscape context. • Continue invasive species removal at conservation areas with Garber’s spurge. Apply herbicides carefully to reduce risk of non-target damage. • Reintroduce/augment populations to sites where the species is extirpated (Green et al. 2008) or has low numbers (Crocodile Lake NWR, Lignumvitae Key Botanical State Park, Long Key State Park, Big Pine Key, Wells Key, Boca Chica Key, Marquesas Key – Short Beach,) and habitat remains or can be restored. • Acquire or pursue conservation agreements for privately-owned properties where the species occurs (Vaca Keys, Boot Key, Big Munson Island). Where present on roadsides, maintain an infrequent mowing regime to allow plants sufficient time to flower and disperse seeds. Do not plant turf grasses in or next to roadside populations. Apply herbicides carefully to reduce non-target damage. Trim hardwoods from edges of population to prevent shading. Communicate these road maintenance guidelines with road maintenance crews. • Expand ex situ propagation and seed banking. Specifically, seeds should be stored within at least one more seed bank in addition to NLGRP for safety duplication. Additionally, seeds have only been collected from one population for long-term storage, but more populations should be safeguarded in ex situ collection for sufficient genetic representation. Seed collections for long-term storage should be made on a regular basis since it is unknown how long Garber's spurge seeds retain viability. Monitoring/Research Activities • Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, coastal habitats, and disturbed areas. • Conduct monitoring to document presence on protected lands at least every five years. • Develop population viability and risk assessments for all populations, based on monitoring and demographic studies. • Determine the condition of populations on private land whose status is currently unknown. • Survey potential habitat within the species historic range on both public and private lands (where access is permitted) for presence of Garber's spurge. • Conduct studies of Keys tidal rock barren habitat to determine successional processes and management needs of the ecosystem. • Conduct genetic studies to clarify relationships with C. porteriana, determine if patterns of morphological variation reported by Herndon (1993) are genetically based, and determine if inbreeding depression is occurring within any populations. • Conduct seed bank studies to determine longevity of seed bank and viability under different conditions, such as presence/absence or intensity of fire. • Conduct research to evaluate reproductive biology, including potential pollinators, insect visitation rates, etc. • Examine the effects of fire (growing season versus non-growing season, various firereturn intervals, etc.) on Garber's spurge flowering, seed set, establishment, reestablishment, etc. • Study impacts of stochastic events (hurricanes, storm surge, tidal flooding, wildfires) on Garber's spurge populations (USFWS, 2022).

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# SPECIES ACCOUNT: *Chamaesyce hooveri* (Hoover's spurge)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 03/26/2016; California/Nevada Region (R8) (USFWS, 2015)

**Physical Description**

Chamaesyce hooveri forms gray-green mats from a few inches to a few feet across. The flowering structure is a small, highly simplified cup-like "cyathium," as in all other spurges (Chamaesyce and Euphorbia). The flowering structure in C. hooveri has petallike glands that are red to olive in color. Flowers bloom in July. (USFWS, 2009)

**Taxonomy**

This plant was originally named Euphorbia hooveri, based on a specimen collected by Hoover in Yettem, Tulare County (Wheeler 1940). At that time, the genus Euphorbia was viewed as comprising several subgenera, including Chamaesyce and Euphorbia. Webster (1975) subsequently elevated the subgenus Chamaesyce to the rank of genus based on growth patterns and physiology. The currently accepted scientific name, Chamaesyce hooveri, was validated when Koutnik (1985) published the new combination. (USFWS, 2009)

**Historical Range**

For decades, Chamaesyce hooveri was known from only three localities: near Yettem and Visalia in Tulare County, and near Vina in Tehama County. Collections were made from these three areas in the late 1930s and early 1940s (Wheeler 1941, Munz and Keck 1959, Stone et al. 1988). From 1974 through 1987, 21 additional occurrences of C. hooveri were reported. The majority of these (15) were in Tehama County. One to three occurrences were discovered during this period in each of Butte, Merced, Stanislaus, and Tulare Counties (Stone et al. 1988). The historical localities for this species were in the Northeastern Sacramento Valley, San Joaquin Valley, Solano-Colusa, and Southern Sierra Foothills Vernal Pool Regions (Keeler-Wolf et al. 1998). (USFWS, 2005)

**Current Range**

Of the 26 occurrences presumed to be extant, only 3 have been observed within the past decade (California Natural Diversity Data Base 2003). The main remaining area of concentration for Chamaesyce hooveri is within the Northeastern Sacramento Valley Vernal Pool Region. The Vina Plains of Tehama and Butte Counties contain 14 (53.8 percent) of the 26 known extant occurrences for C. hooveri (California Natural Diversity Data Base 2003) in an area of about 91 square kilometers (35 square miles; Stone et al. 1988). One other site in the same region is near Chico in Butte County. Seven of the extant occurrences are in the Southern Sierra Foothills Vernal Pool Region, including five in the Visalia-Yettem area of Tulare County and two in the Hickman-La Grange area of Stanislaus County. Three other occurrences are on the Sacramento National Wildlife Refuge in Glenn County, which is in the Solano-Colusa Vernal Pool Region. The one other extant occurrence is on the Bert Crane Ranch in Merced County, which is within the San Joaquin Valley Vernal Pool Region (Keeler-Wolf et al. 1998, California Natural Diversity Data Base 2003). (USFWS, 2005)

**Critical Habitat Designated**

Yes; 2/10/2006.

**Legal Description**

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chamaesyce hooveri (Hoover's spurge) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in California (71 FR 7118-7316).

**Critical Habitat Designation**

The critical habitat designation for Chamaesyce hooveri includes seven CHUs in Merced, Stanislaus, Tehama, Tulare, and Tuolumne Counties, California. This species critical habitat encompasses approximately 114,713 acres (71 FR 7118-7316).

Unit 1: Tehama County, California. From USGS 24,000 topographic quad Acorn Hollow, Richardson Springs NW

Unit 2: Butte County, California. From USGS 24,000 topographic quad Hamlin Canyon

Unit 4: Stanislaus and Tuolumne Counties.

Unit 5: Stanislaus and Merced Counties. (i) Unit 5A: Stanislaus and Merced Counties. From USGS 24,000 topographic quads Paulsell, Cooperstown, Le Grange, Montpelier, Turlock Lake, Snelling, Merced Fall. (ii) Unit 5B: Merced County. From USGS 24,000 topographic quad Turlock Lake. USGS 24,000 topographic quads Paulsell, Montpelier.

Unit 6: Merced County. (i) Unit 6A: Merced County. USGS 24,000 topographic quads Stevinson, San Luis Ranch. Unit 6B: Merced County. From USGS 24,000 topographic quad Stevinson, Arena, San Luis Ranch, Turner Ranch. Unit 6C: Merced County. From USGS 24,000 topographic quad Arena, Turner Ranch. Unit 6D: Merced County. USGS 24,000 topographic quad Turner Ranch, Sandy Mush. Unit 6E: Merced County. USGS 24,000 topographic quad Turner Ranch, Sandy Mush.

Unit 7: Tulare County. (i) Unit 7A: Tulare County. From USGS 24,000 topographic quads Stokes Mtn., Ivanhoe. Unit 7B: Tulare County. From USGS 24,000 topographic quads Ivanhoe. (iii) Unit 7C: Tulare County. From USGS 24,000 topographic quads Stokes Mtn., Auckland, Ivanhoe, Woodlake. Unit 7D: Tulare County. From USGS 24,000 topographic quad Woodlake. Unit 7E: Tulare County. From USGS 24,000 topographic quad Monson. Unit 7F: Tulare County. USGS 24,000 topographic quad Monson. Unit 7G: Tulare County. USGS 24,000 topographic quad Monson.

Unit 3: Glenn and Colusa Counties, California. This unit was excluded from the designation pursuant to Section 4(b)(2) of the Act (see Exclusions under 4(b)(2) in the final critical habitat rule (70 FR 46924).

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chamaesyce hooveri critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described below in paragraph (2)(ii), providing for dispersal and promoting hydroperiods of adequate length in the pools;

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands;

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas determined to be essential for conservation may require special management considerations or protections. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species. Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Many of the factors that cause the decline and localized extirpation of vernal pool species can be avoided. Actions that should be avoided include the following: (1) Actions that increase competition from invasive species as many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDB 2001). (2) Alteration of natural hydrology such as construction of dams or other structures that artificially increase the length of vernal pool inundation or construction of ditches that artificially drain vernal pools. (3) Human degradation of vernal pools such as off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (annual) (USFWS, 2005)

**Dependency on Other Individuals or Species**

Adult: Beetles (order Coleoptera), flies (order Diptera), bees and wasps (order Hymenoptera), and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of Chamaesyce hooveri and may potentially serve as pollinators (Stone et al. 1988, Alexander and Schlising 1997). (USFWS, 2005)

**Breeding Season**

Adult: Late May to October (USFWS, 2005)

**Reproduction Narrative**

Adult: Chamaesyce hooveri is a summer annual, but few details of its life history are known. Populations in Merced and Tulare Counties typically flower from late May through July, whereas those farther north in Stanislaus County and the Sacramento Valley flower from mid-June into October (Alexander and Schlising 1997, J. Silveira in litt. 2000, California Natural Diversity Data Base 2003). Beetles (order Coleoptera), flies (order Diptera), bees and wasps (order Hymenoptera), and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of Chamaesyce hooveri and may potentially serve as pollinators (Stone et al. 1988, Alexander and Schlising 1997). (USFWS, 2005)

**Habitat Type**

Adult: Temporary pool (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Vernal pools (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (USFWS, 2005)

**Site Fidelity**

Adult: High (inferred from USFWS, 2005)

**Habitat Narrative**

Adult: Chamaesyce hooveri is restricted to vernal pools (Stone et al. 1988, Koutnik 1993, Skinner and Pavlik 1994). Deeper pools apparently provide better habitat for this species because the duration of inundation is longer and the deeper portions are nearly devoid of other vegetation, thus limiting competition from other plants (J. Stebbins in litt. 2000a, Stone et al. 1988). However, the plant appears to adapted to a wide variety of soils, which range in texture from clay to sandy loam. (USFWS, 2005)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

25 (USFWS, 2023)

**Population Size:**

100-2,500 (USFWS, 2009)

**Population Narrative:**

Population numbers have ranged from less than 100 plants seen in 2001 to over 2,500 plants seen in 1993 (J. Silveira, in litt. 2009). Of the 31 known occurrences and sites, 27 are presumed to be extant (LSA 2003; CNDDB 2007). (USFWS, 2009) Hoover's spurge is endemic to the Central Valley of California. The known distribution is within a narrow zone of rolling topography formed by remnant alluvial fans and stream terraces on the eastern margin of the Sacramento and San Joaquin valleys (Stone et al. 1988, p. 102). Assessment of the historical range of Hoover's spurge is complicated as the earliest floristic surveys occurred after widespread conversion of potentially suitable habitat to agriculture (Stone et al. 1988, p. 106). The present distribution of Hoover's spurge is likely considerably fragmented compared to historical conditions (Stone et al. 1988, p. 106). Hoover's spurge is known from a few widely separated populations (see Table 1). Occurrences are recorded in four different vernal pool recovery regions. The main area of concentration is within the Northeastern Sacramento Valley Vernal Pool Region on the Vina Plains along the Tehama and Butte County line. Occurrences in the Solano-Colusa Vernal Pool Region are clustered on the Sacramento National Wildlife Refuge in Glenn County. In the Southern Sierra Foothills Vernal Pool Region, occurrences are adjacent to Turlock Lake State Recreation Area in Stanislaus County and on the Stone Corral State Ecological Reserve north of the City of Visalia in Tulare County. One occurrence is within the San Joaquin Valley Vernal Pool Region on the Grasslands Wildlife Management Area in western Merced County. The species' current distribution remains similar to the distribution as described in the 1997 listing rule and the 2009 status review. At the time of listing, Hoover's spurge was known from 29 populations found in Butte, Glenn, Merced, Stanislaus, Tehama, and Tulare counties, 25 of which were considered extant (Service, 1997, p. 1431). The 2009 status review notes a total of 31 occurrences of the species, including 30 occurrences recorded in the Diversity Database and an additional occurrence at the then-proposed Hamilton Ranch Conservation Bank that had not yet been included in the Diversity Database (Diversity Database 2007, entire; Service 2009, pp. 1–2). Twenty-seven occurrences were presumed to be extant in 2009 and the occurrences were distributed throughout the same counties and concentrated in the same areas as the populations described at the time of listing (Diversity Database 2007, entire; Service 2009, p. 2). There have been only minor changes to the occurrences of Hoover's spurge recorded in the Diversity Database since the 2009 status review. Currently the Diversity Database describes a total of 29 occurrences (see Table 1; Diversity Database 2023, entire). The new occurrence reported in the 2009 status review at the Hamilton Ranch Conservation Bank has been incorporated into the Diversity Database (occurrence #36). Two additional records (occurrences #34 and #35) have been added to the Diversity Database and four records (occurrences #17, #18, #20, and #31) have been combined with other existing occurrence records (see Table 1; Diversity Database 2007, entire; Diversity Database 2023, entire). The two additional records (occurrences #34 and #35) are located within the Sacramento National Wildlife Refuge in proximity to other occurrences of the species on the Refuge and were previously considered as parts of the other occurrences (Diversity Database 2023, pp. 33–34). Two previously unreported areas of occupied habitat documented by Witham (2013, pp. D-1–D-5) have also been added to the Diversity Database as part of existing records (occurrences #36 and #13) (Diversity Database 2023, pp. 13, 35). Twenty-five occurrences are currently presumed to be extant, two possibly extirpated, and two extirpated (Diversity Database 2023, entire). Since the 2009 status review, the status of occurrence #29, which is located in proximity to two other occurrences in the northern portion of the range, has changed from “presumed extant” to “possibly extirpated” due to the intensification of agriculture. Other “presumed extant” occurrences from the last status review remain in this category currently. Witham’s 2013 status review of Hoover’s spurge and its supporting habitat found potentially suitable habitat to be present at each “presumed extant” location (Witham 2013, entire). The current status of many “presumed extant” populations has not been reassessed through on-the-ground surveys in many years, and areas that may support the species remain to be surveyed. Thus, reliable estimates of the amount and distribution of suitable habitat is unknown (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat loss
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, paving, and other activities, as well as modification of surrounding uplands, which alters vernal pool watersheds and the supporting upland ecosystem. Fifty-five percent of presumed extant sites of C. hooveri are on private land and are not protected (CNDDB 2007). (USFWS, 2009)

**Stressor:** Agriculture conversion
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** During the 30 years prior to listing, agricultural land conversion was known to have caused the extirpation of one population and threatened two more populations of Chamaesyce hooveri in Tulare County (Stone et al. 1988). In Stanislaus County, the area east of Waterford and Hickman was being converted into grainfields, almond orchards, and irrigated pasture. Thus agricultural land conversion in this area threatened 2 more existing populations of C. hooveri (Stone et al. 1988). It is likely that several occurrences were eliminated by habitat losses before they became known, mainly from conversion of vernal pool habitat to agricultural uses (Stone et al. 1988). We estimated a total of nearly 5,600 acres had been converted, with the greatest acreage, approximately 5,000 acres, converted within the Merced core area. Additionally, one of the occurrences of Chamaesyce hooveri within the Vina Plains core area appears to have been converted to more intensive agriculture. (USFWS, 2009)

**Stressor:** Habitat degradation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Vernal pool habitats in the Central Valley now represent approximately 9 percent of their former area (State of California 2003), and remaining habitats are considerably more fragmented and isolated than historically and during the recent past. California’s human population is expected to increase by 60 percent between 2000 and 2025 (California Department of Finance 2004) and almost double the 1990 State population. In areas where habitat remains, increased urban conversion of vernal pool habitat continues to threaten this species and habitat loss is expected to continue as urban boundaries expand further especially through high and low

terrace formations on the eastern side of the valley. Even in areas where habitat is protected, the urbanization of lands surrounding conserved areas results in the fragmentation of protected habitats, preventing dispersal between occurrences, as well as increased edge effects to pool complexes. Habitat conversion is expected to continue as the human population increases (Teitz et al. 2005). (USFWS, 2009)

**Stressor:** Nonnative plants
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from invasive native or non-native plant species threatens nine of the extant occurrences, including eight in the Vina Plains and one on the Sacramento National Wildlife Refuge in Glenn County. Native competitors of Chamaesyce hooveri include Eryngium species (coyote-thistle), Malvella leprosa (alkali mallow), a noxious weed according to Hill (1993), Phyla nodiflora (lippia), Scirpus acutus var. occidentalis (hard-stemmed tule, alkali bulrush (Scirpus maritimus), and Xanthium strumarium (cocklebur). Non-native competitors include bindweed (a noxious weed according to Dempster 1993) and Crypsis schoenoides (swamp grass) (J. Silveira in litt. 2000; CNDDB 2007). On the Vina Plains Preserve, the pools with Chamaesyce hooveri also had the highest frequency of bindweed, at least in 1995 (Alexander and Schlising 1997). Increasing dominance by these competitors may be associated with changes in hydrology and livestock grazing practices (Stone et al. 1988, Alexander and Schlising 1997; CNDDB 2007). Due to late spring rains during the last few years, an invasive plant, Crypsis vaginiflora has become dominant in many Basin-Rim vernal pools within the Sacramento NWR Complex (Sacramento, Delevan and Colusa). (USFWS, 2009)

**Stressor:** Drought and climate change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Chamaesyce hooveri is an obligate wetland species found only in vernal pools, typically on alluvial fans or terraces of ancient rivers or streams, with a few on the rim of the Central Valley basin. Therefore, maintenance of the natural hydrology of the pools is necessary for the survival and recovery of this species. Drought or flood conditions will place additional strains on the vernal pool ecosystem supporting C. hooveri occurrences, some of which are already fragmented or reduced by agricultural conversion and development. Where occurrences persist on only marginal habitat, the addition of extreme drought conditions is likely to result in higher rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. (USFWS, 2009)

**Stressor:** Stochastic events
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small population size poses a serious threat for at least four of the known occurrences, which total fewer than 100 individuals even in favorable years (CNDDB 2007). Such small populations are subject to extirpation from random events such as extended drought and genetic drift. Small population size makes it difficult for this species to persist while sustaining the impacts of habitat fragmentation. Such populations may be highly susceptible to extirpation

due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). (USFWS, 2009)

**Stressor:** Neonicotinoid pesticides (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. All three pesticides were determined likely to adversely affect Hoover's spurge, primarily due to expected effects to its pollinators. The likely to adversely affect determination means that the Agency reasonably expects that at least one individual animal or plant, among a variety of listed species, may be exposed to the pesticide at a sufficient level to have an effect, which will be adverse. The three pesticides target insect neurotransmitters leading to their paralysis and death. The three pesticides are highly toxic to bees and available data suggest that all three pesticides are likely to affect honeybee and bumblebee colonies through brood reduction and declines in numbers of adults. The specific pollinators of Hoover's spurge are not known. Pollinators of similar species of Euphorbiaceae are usually generalists: small bees, flies, and wasps. During a field study of Hoover's spurge, Stone et al. (1998, p. 105) observed species of native bees and the western honeybee (Apis mellifera) visiting plants. Since the plant is believed to require insect pollination, a loss or severe decline in pollinators of Hoover's spurge would adversely impact the reproductive success of the species. The Agency anticipates releasing amended proposed interim decisions in 2023, which will include updates to some of the previously proposed mitigation measures to reduce neonicotinoid exposures for listed species. Mitigation measures will be finalized in the interim decisions, which the Agency expects to release in 2024 mitigation measures (USFWS, 2023).

**Stressor:** Livestock grazing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Appropriate levels of grazing are a vital component of long-term management for vernal pools and vernal pool grasslands. Before their populations declined, elk (Cervus canadensis) and pronghorn (Antilocapra americana) grazed vernal pool landscapes; today, most grazing is done by domestic ungulates (Service 2005, p. I-16). The 2009 status review describes livestock grazing and trampling as an activity that may or may not adversely affect vernal pool plants, depending on how it is implemented (Service 2009, p. 16). The most recent occurrence report for Hoover's spurge from the Diversity Database lists 21 of the 25 "presumed extant" occurrences as threatened by grazing. Clarifying notes state the threat from grazing is due to trampling, winter grazing, and grazing aiding the establishment of weedy exotic plants. In one instance, threats are identified from undergrazing (Diversity Database occurrence #32). The threat grazing poses to Hoover's spurge, and other vernal pool plants, remains an active field of study. Most researchers and land managers currently agree that some level of grazing is beneficial if not necessary for maintaining the ecological health and functioning of vernal pools (Robins and Vollmar 2002, p. 402). New and collected research is presented here (USFWS, 2023).

**Stressor:** Climate change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Significant research into the effects of climate change throughout California has been conducted since the previous status review in 2009. The most recent comprehensive climate change assessment for the state, California's Fourth Climate Change Assessment (Fourth Assessment), was published in 2018 (Bedsworth et al. 2018, entire). Climate change will increase temperatures, sea levels, intensity of heavy precipitation events, decrease snow accumulation, increase the frequency of drought, and increase the size of wildfires (Bedsworth et al. 2018, p. 22). Present-day temperatures have increased over most of the state by at least 1°F compared to earlier in the 20th century. Annual average maximum daily temperatures are expected to further increase by 2.5°F to 8.8°F by 2100 (van Vuuren et al. 2011, p. 11). Some variability is anticipated by region, but the direction of warming trends, as well as precipitation, drought, and wildfire are expected to be similar in the Sacramento Valley (Houlton and Lund 2018, pp. 6–8) and San Joaquin Valley (Fernandez-Bou 2021, pp. 7–10) of California where Hoover's spurge occurs. Climate models predict precipitation will be more volatile; the number of drought years will increase, while the storms that occur in wet years will bring more precipitation and flood risk concentrated in a fewer number of days (Bedsworth et al. 2018, pp. 25–26). Since vernal pool vegetation varies from year to year based on climatic conditions such as precipitation amount and timing and air temperatures, climate change could drive changes in plant communities (Montrone et al. 2019, p. 1004; Javornik and Collinge 2016, p. 66). An increase in drought occurrence can also lead to invasion of vernal pool habitats by invasive upland plants during low water years and could result in the competitive exclusion of vernal pool plants such as Hoover's spurge. Hoover's spurge is most often found in large, deep pools that are characterized by prolonged inundation in the spring followed by gradual desiccation during the late spring and early summer (Stone et al. 1988, p. 102). Populations of Hoover's spurge will likely be threatened by changes to vernal pool water budgets—the total length of time a pool is inundated, and the rate of drying—under climate change. Assuming precipitation levels remain near historical levels and only temperature increases, modeled data suggest a decrease in the length of time pools are filled (Montrone et al. 2019, p. 1004). A reduction in pool inundation period will likely impact species adapted to long inundation times to a greater degree (Gosejohn et al. 2016, p. 9; Montrone et al. 2019, p. 1004). Since Hoover's spurge is associated with pools with long inundation times, it could be at greater risk of decline or extirpation if average hydrological conditions become unfavorable. Increased temperatures can also impact the rate at which vernal pools dry in the late spring and summer. Increased temperature late in the growing season may cause the pools to dry too rapidly and hinder native plant development (Javornik and Collinge 2016, p. 66). Stone et al. (1988, p. 105) observed Hoover's spurge seedlings have less time to develop if a pool dries too rapidly. Under such conditions, plants can be poorly developed and have reduced reproductive success or may even die prematurely (Stone et al. 1988, p. 105). It should be noted that both the inundation length and rate of drying are controlled by multiple factors. The timing of rain events within a year, total amount of precipitation, and period between storms can influence the aquatic phase of vernal pools in addition to air temperature (Alexander and Schlising 1997, p. 120; Javornik and Collinge 2016, pp. 64–66). Due to its requirement for vernal pools with long inundation times and preference for long pool drying periods, Hoover's spurge will likely be negatively affected under most climate change scenarios (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 8C

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Protect vernal pool habitat in the largest blocks possible from loss, fragmentation, degradation, and incompatible uses. (USFWS, 2005)
- Manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern. (USFWS, 2005)
- Conduct range-wide status surveys and status reviews for all species addressed in this recovery plan to determine species status and progress toward achieving recovery of listed species and long-term conservation of species of concern. (USFWS, 2005)
- Conduct research and use results to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts.
- Develop and implement participation programs. (USFWS, 2005)
- Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquiring conservation easements or fee title to habitat lands are some ways that conservators can help guarantee protection of the species in perpetuity. (USFWS, 2009)
- Develop standardized population trend survey protocols and implement to complete updated status surveys, especially for populations on private lands where trends have not been recently updated. (USFWS, 2009)
- Manage invasive plants on preserves. Management should include research to determine effective eradication methods of nonnative competitors, and pool conditions that favor one plant over another. (USFWS, 2009)
- Create and convene regional vernal pool working groups in regions where Chamaesyce hooveri occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas. (USFWS, 2009)
- Collect seeds from each core area following the Center for Plant Conservation Guidelines (1991). Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: In this section, we propose recommendations that will aid in the recovery and conservation of Hoover’s spurge. The recommendations put forth in the Recovery Plan (Service 2005, pp. ix–xii) and the 2009 status review (Service 2009, p. 21) are still relevant. Three additional recommendations are added based on communication with species experts, a literature search, and a status review of existing records. 1. Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquiring habitat

through conservation easements or fee title are some ways that conservators can help guarantee protection of the species in perpetuity. 2. Develop and implement standardized population trend survey protocols to complete updated status surveys, especially for populations on private lands where trends have not been recently updated. 3. Manage invasive plants on preserves. Management should include research to determine effective eradication methods of nonnative competitors, and pool conditions that favor native vernal pool plants over invasive plants. 4. Create and convene regional vernal pool working groups in regions where Hoover's spurge occurs. Regional vernal pool working groups will be important for tracking the progress of recovery efforts, including the amount of suitable habitat protected for the species in core areas. 5. Collect seeds from each core area following the standard accepted practices. After genetic studies are completed, additional collections should be made from each population that contains unique genotypes. Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. Repeated small collections of seed may be necessary over several years to avoid contributing to the decline of very small populations. 6. Conduct research to confirm pollinator species of Hoover's spurge. Initiate monitoring of pollinator species to determine if there are any trends in pollinator numbers that could be inhibiting the ability of Hoover's spurge to successfully reproduce. 7. Conduct research on potential grazing regimes that target invasive native and nonnative plant species without harming Hoover's spurge or its lifecycle. Gain a better understating of how periodic disturbance from livestock grazing might aid in reducing interspecific competition with Hoover's spurge. Any resulting recommendations should be based on observable habitat conditions, such as water levels in vernal pools, since inundation periods are variable between years and are anticipated to be impacted by climate change. 8. Continue research on the demography of Hoover's spurge and its seed ecology. A better understanding of the species seed bank viability is needed to determine when local populations may be assumed to be extirpated versus simply dormant. 9. In order to reflect the most current understanding of the species' taxonomy, formally change the species name in the Code of Federal Regulations from Chamaesyce hooveri to Euphorbia hooveri (USFWS, 2023).

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# SPECIES ACCOUNT: *Chionanthus pygmaeus* (Pygmy fringe-tree)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/20/1987; Southeast Region (R4)

**Physical Description**

Pygmy fringe tree is a shrub or small tree that is often less than 1 m (3 feet tall), but can reach 4 m (feet). The twigs are opposite or sub-opposite and stiff, while the leaf scars and leaves are mostly opposite but sometimes alternate. The leaves are simple, mostly 3 to 10 cm (about 1 to 4 inches) long, and lacking stipules. They have short petioles, and the somewhat leathery blades are ovate to elliptic or obovate in shape, and acute to rounded at the tip. The base of the blade is attenuated to the petiole. The upper surface of the blade is dark yellow-green and smooth, but the lower surface is paler and reticulate. The inflorescence is a leafy-bracted panicle that appears with the new shoots from the axils of most leaf scars from the previous season. The axis (main stem) of the inflorescence is rather short with numerous opposite branches that are spreading, slender and dropping, terminating in clusters of three to six flowers. Bracts toward the base of the inflorescence are similar to, but smaller than, the leaves. The flowers are regular, perfect, and pleasingly fragrant. The four sepals are green, united at the base, and 1.5 to 2.0 millimeters (mm) long. The four petals are white, united at the base to a short, campanulate throat, with narrowly linear lobes, 1.0 to 1.5 cm long and somewhat spreading. The two stamens are fused (adnate) to the corolla base. The ovary is superior with a single style. The fruit is a drupe 2.0 to 2.5 cm long, oval, and green, becoming purplish-brown when ripe. (USFWS, 1999)

**Taxonomy**

Small (1933) named this species Chionanthus pygmaea. Since then there have been no other taxonomic treatments. There are no scientific synonyms, but the common name used in literature is pygmy fringetree and the spelling variation pygmy fringe-tree (Wood 1985, Ward and Godfrey 1979). The gender of the name has been unclear. When he named the species, Small (1933) used the Greek suffix -aea which indicates the species? status as a tree. The use of this ending has been questioned and every author since, including Hardin (1974), has used the suffix -aeus indicating its status as a shrub. (USFWS, 1999)

**Historical Range**

Lake, Osceola, Polk, and Highland Counties, Florida. No longer found on the Mount Dora Range (USFWS, 1999).

**Current Range**

Chionanthus pygmaeus is known from west of Lake Apopka in Lake County, northwestern Osceola County, and the Lake Wales Ridge in Polk and Highlands counties, Florida. (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Although the reproductive biology of this species has not been thoroughly investigated, it is known to spread by root sprouts and occasionally by seed (Stout in press). The plants appear to be functionally dioecious (Gill and Pogge 1974), and the female flowers have stunted anthers that usually do not open (Goodrum and Halls 1961). The four plants in the endangered species display garden at the Historic Bok Sanctuary (2 males, 2 females) flowered and set seed in 1997 (Center for Plant Conservation 2003). After spring flowering, fruiting probably occurs in June, with seed dispersal in September (Gill and Pogge 1974, Ward and Godfrey 1979). Seeds (drupes) may remain on the plants well into winter (Stout 2001, in press). Little is known about seed dissemination of pygmy fringe tree, and seed production is variable from year to year, with mixed reports for success of germination. In nursery conditions the best results are obtained with cleaned, air-dried seed, but whole fruits have also germinated. Bok Tower Gardens has achieved 60 to 70 percent germination rates under greenhouse conditions (T. Race, Bok Tower Gardens, personal communication 1996). Germination dates for pygmy fringe tree are unknown. Leafing occurs mid-March, budding occurs in March, and anthesis is from late March to early April. Recruitment is exceedingly slow in this species. At The Nature Conservancy's Tiger Creek Preserve (Possum Creek Trail Scrub), over 100 individuals of pygmy fringe trees have been tagged and monitored (I.J. Stout, University of Central Florida, personal communication 1997). In more than 10 years of monitoring, hundreds of root sprouts were found, but only one seedling was located. Despite this extremely low seedling recruitment, the number of individuals at the site appears to be stable. Due to population stability and this species' reliable resprouting after fires, The Nature Conservancy no longer conducts detailed monitoring on this species (B. Pace-Aldana, The Nature Conservancy, in litt. 2005). This species is long-lived and persists in scrub that is burned on a frequency between 20 and 70 years. However, it is a fire-dependent species that resprouts after fire events. This species has above-ground stems growing from rootstocks or buried stems that have survived the infrequent fires that are characteristic of the habitat (Kral 1983, Ward and Godfrey 1979). It has been observed to resprout from rootstocks following a spring burn (Stout in press). Fires may have an important indirect effect on pygmy fringe tree by regulating the numbers and sizes of plants that might shade or otherwise compete with it (Kral 1983). In the spring and summer of 1997, The Nature Conservancy burned sandhill vegetation at Tiger Creek Preserve that contains pygmy fringe tree. The effects of fire on these individuals were monitored (I.J. Stout, personal communication 1997). Burning to restore the sandhill vegetation's original grassy appearance continues, and Bea Pace has monitored the results (Center for Plant Conservation 2003). Pygmy fringe tree is also present at the Carter Creek tract of Lake Wales Ridge National Wildlife Refuge, where restoration of sandhill is being studied by Archbold Biological Station (Menges et al. 2005). Their results to date "suggest that burning is beneficial for sandhill community structure and the populations of several key species. Chainsawing as a pre-treatment has mixed results depending on the species. . . . The saw & burn treatment promotes more complete and intense fires (Menges et al. unpubl. data) and more open post-treatment subcanopies, which may have a number of benefits for restoration of the sandhill ecosystem and its species. Subsequent fires may be more effective in areas impacted once with this mechanical pre-treatment to fire."

**Habitat Type**

Adult: Dry/Xeric Hammocks

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Pygmy fringe tree inhabits excessively drained sandy soils on central Florida's LWR (and historically on the Mount Dora Ridge, Orange County). This species is found on low- nutrient St. Lucie fine sand soil which is subject to rapid drying (Wunderlin et al. 1981), as well as other dry sand soils. Pygmy fringe tree occurs primarily in scrub as well as high pine, dry hammocks, xeric hammocks, and transitional habitats. It is abundant at a few sites, where it may form thickets along with evergreen oaks and other shrubs such as tallow wood, silk bay, and scrub hickory. In some locations, it may be the dominant plant while in others it may be codominant or subdominant (Wunderlin et al. 1981). At Carter Creek, where it is relatively abundant, it is scattered among turkey oaks.

***Dispersal/Migration***

***Population Information and Trends***

**Population Narrative:**

This species is protected on a substantial number of conservation lands, most of them purchased after it was listed. It has been monitored at LWR State Forest (Weekley 1996, 1999), and it is clearly a long-lived resprouting species. The Service does not have current information on threats because this shrub is considered relatively abundant and secure by managers of the conservation lands of the Lake Wales Ridge, so limited funds for monitoring have been devoted to other species. After this plant was listed, an extensive network of state conservation lands and the Lake Wales Ridge National Wildlife Refuge came into existence, providing habitat and habitat management supported by extensive ecological research and monitoring programs.

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The rapid loss of suitable scrub habitat in Central Florida to residential, recreational and related commercial development is of the utmost concern. Some of these well drained upland soils are also being converted to citrus production. The long term exclusion of fire from the scrub can lead to a dense canopy layer unfavorable to the growth of the short pygmy fringetree. (NatureServe, 2015)

***Recovery***

**Reclassification Criteria:**

1. Wen existing populations, within the historic range of C. pygmaeus, are adequately protected from further habitat loss, degradation, and fire suppression. Large areas of land are needed to support populations of this tree/shrub species. These sites must also be managed to maintain xeric oak scrub to support C. pygmaeus. Habitat destruction is occurring at an alarming rate. To ensure the survival of this species, actions must be taken to protect its remaining habitat.

Difficulty in conserving this species may be compounded by the low seed germination rates that could affect this plant's ability to rebound from a reduction of adult individuals. (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of C. pygmaeus, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the serial stage of xeric oak scrub to support C. pygmaeus (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 1999)

**Recovery Actions:**
- Determine current distribution of C. pygmaeus. This species' distribution is somewhat questionable for taxonomic reasons and ease of overlooking individuals. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of C. pygmaeus. Develop monitoring protocol to assess population trends for C. pygmaeus. Develop a quantitative description of the population structure of C. pygmaeus. (USFWS, 1999)
- Provide public information about C. pygmaeus. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of C. pygmaeus. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of C. pygmaeus and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level

research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Work with State, Federal, and non-profit partners to ensure adequate fire and invasive species management is achieved at sites that support pygmy fringe-tree. • Determine limiting factors and preferred microsites for seedling recruitment. • Develop a standard methodology for monitoring pygmy fringe-tree on conservation lands. • Acquire or secure permanent easements on private sites with existing populations from willing sellers, and restore scrub habitat on these sites, including implementing prescribed fire and vegetation thinning by hand. • Work with private landowners to conserve extant populations. • Initiate detailed demographic monitoring (Level 3 monitoring sensu Menges and Gordon 1996) at multiple sites throughout the species' range. • Conduct a prescribed fire in one or more of the study populations at Tiger Creek Preserve to better understand the response of pygmy fringe-tree and to integrate fire management into population viability models. • Determine the overall level of threat posed by seed and fruit predators, especially the unidentified weevil. • Determine the overall level of threat to pygmy fringe-tree posed by the moth larva Palpita illibalis and white-tailed deer. • Conduct basic research on the breeding system and pollination biology of pygmy fringe-tree. • Initiate studies to determine the genetic structure of pygmy fringe-tree populations throughout the species' range. • Ensure representation of pygmy fringe-tree at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. • Strengthen ex situ conservation measures by including a wider sample (from numerous sites across the species range) of this species at Bok Tower Gardens, in both stored seed and living collections. • Conduct germination trials on stored seed to determine their long-term viability and factors that affect seed dormancy. (USFWS, 2021)

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# SPECIES ACCOUNT: *Chorizanthe orcuttiana* (Orcutt's spineflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/07/1996; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An annual herb with prostrate, yellowish stems, 1-15 cm long. Yellow, densely hairy flowers (2.5-4 mm) bloom March-April and produce a single seed. (NatureServe, 2015)

**Taxonomy**

Not available

**Historical Range**

See current range/distribution.

**Current Range**

Known only from San Diego County, California. All of the known occurrences of this species are within 5 km of the Pacific Ocean at elevations below 100 m above mean sea level (Bauder 2000). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 2007)

**Breeding Season**

Adult: March to April (NatureServe, 2015)

**Reproduction Narrative**

Adult: Chorizanthe orcuttiana (Orcutt’s spineflower) is a small (1-15 cm), annual plant species known only from San Diego County, California. C. orcuttiana flowers bloom from March to April (NatureServe, 2015). (USFWS, 2007; NatureServe, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Maritime shrubland/chaparral (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Small patches (USFWS, 2007)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from USFWS, 2007)

**Habitat Narrative**

Adult: Chorizanthe orcuttiana prefers open areas with sandy soils within low, fairly open southern maritime chaparral communities. (NatureServe, 2015). Soil samples examined were dominated by the sand fraction with moderate acidity, low organic content and nitrate nitrogen (Bauder 2000). The four extant occurrences are small patches often with constricted connectivity to adjacent patches. The habitat of C. orcuttiana is described as loose sandy soils in openings in coastal or maritime chaparral by Bauder (2000, p. 31). (USFWS, 2007; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

9 Extant, 1 possibly extant (USFWS, 2021)

**Population Size:**

470 to 3,000 (USFWS, 2007)

**Population Narrative:**

Currently we consider there to be four extant occurrences of Chorizanthe orcuttiana, one at Oak Crest Park in Encinitas and three on Point Loma. For the four occurrences considered to be currently extant, the highest recorded number of plants for any single occurrence was 2,520 plants in 1998 at Point Loma (EO 12) (Bauder 1998). Recent plant counts for all of the extant occurrences combined range from a high of about 3,000 to a low of about 470 plants. (USFWS, 2007) In summary, annual monitoring of Chorizanthe orcuttiana occurrences since 2014 has provided new information about plant abundance. We have updated our 2014 occurrence status determinations and added the additional occurrences (Appendix A). Based on those updates, there are 21 occurrences of C. orcuttiana with 9 extant, 9 extirpated, 1 possibly extirpated, and 2 research sites. While the extant distribution within the range has increased since the last review, the historical range of C. orcuttiana remains highly limited and has not changed since the previous review. Occurrences of C. orcuttiana, including the newly discovered sites, remain small and isolated throughout the range, and likely susceptible to local stochastic events. Additionally, all occurrences continue to face multiple threats including habitat degradation (trampling, recreational use, erosion), habitat loss (development, road/trail maintenance, fire), invasive species pressure, small population size, and climate change. The information received since the previous review does not appreciably alter our understanding of the species’ distribution, ecology, or threats (Appendix A). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Maritime chaparral as the habitat type with which Chorizanthe orcuttiana is associated and it is estimated that there were 1,500 to 3,700 acres of southern maritime chaparral habitat remaining in San Diego County and 150 acres in Orange County. The Service stated that this represented an estimated loss of between 82 and 93 percent of southern maritime chaparral in San Diego County. (USFWS, 2007)

**Stressor:** Random events (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the final listing rule (USFWS 1996 p. 52381) Chorizanthe orcuttiana was considered threatened by naturally occurring random events exacerbated by drought or fire because of the species' restricted distribution and the small size of the known population. (USFWS, 2007)

**Stressor:** Invasive plant species (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive exotic grass and weed species as well as interruption of the natural fire cycle were also considered threats to this species. Muhlenbergia rigens (deergrass), a native grass species, was removed from some of the habitat at Oak Crest Park because of its potential to crowd out and shade the Chorizanthe orcuttiana (Bauder 2000 p. 21). The lack of a natural fire regime or managed alternative for the associated southern maritime chaparral may pose a threat to Chorizanthe orcuttiana by allowing the shrub canopy to cover over the sandy openings favored by the Orcutt's spineflower. (USFWS, 2007)

**Stressor:** Fire (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The natural fire cycles in the area have likely been altered. A single natural random event, such as a fire, could jeopardize the continued existence of the species at one or more of the occurrences by killing standing plants, reducing input to the seed bank, or by being intense enough to kill some of the seeds in the seed bank. Such an event could also reduce vegetation cover and result in erosion and loss of habitat. (USFWS, 2007)

**Stressor:** Invasive non-native plant species (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive non-native plants are the greatest known threat to the occurrences of Orcutt's spineflower on Point Loma. The invasive non-native Carpobrotus edulis (Hottentot fig;

iceplant) covers many of the open sandy areas on Point Loma (Bauder 2000). Iceplant produces thick layers of prostrate, succulent stems and leaves over the soil surface, deposits organic material, and grows back readily after removal (Bauder 2000). Rhynchelytrum repens (Natal grass) is another nonnative plant that threatens Orcutt's spineflower (Rusev and Zink 2005). A potentially invasive Acacia spp. has also been identified at Point Loma (Bauder 2000). These species can prevent expression of the above ground population of Orcutt's spineflower. If this is a long-term condition, presumably the seed bank would eventually be depleted thereby diminishing the range of the species. (USFWS, 2007)

**Stressor:** Small populations (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Chorizanthe orcuttiana (Orcutt's spineflower) has never been known to be abundant or widespread. Local populations are still relatively to extremely small. (USFWS, 2007)

**Stressor:** Recreation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The occurrence at Oak Crest Park was fenced in 2000 with money from a section 6 grant through the State to the City of Encinitas. The open rail fence affords the occurrence protection from casual walkers and other recreational activities, noted as threats in the listing rule. (USFWS, 2007)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 5

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Recovery actions are not available.
- Continue to work with the City of Encinitas and the U.S. Navy to protect and enhance habitat for Chorizanthe orcuttiana. (USFWS, 2007)
- Eliminate negative impacts from non-native and native vegetation on the known occurrence of the species in Oak Crest Park, Encinitas. (USFWS, 2007)
- Determine the presence and location of similar sites in Oak Crest Park, Encinitas and create clearings among the vegetation on suitable soils. (USFWS, 2007)
- Field-check the historical occurrence sites and suitable habitat identified by Bauder (2000) to verify the presence of suitable habitat and the presence or absence of the species. (USFWS, 2007)

- Determine the reproductive cycle of the species to include pollen and seed dispersal agents, fecundity of the species in relation to rainfall patterns, and any identifiable bottlenecks to the species survival other than those already known. (USFWS, 2007)
- Determine the most effective manner to consistently limit the impact of invasive non- native plants on this species. These may have to be site and/or species specific. (USFWS, 2007)
- Determine and implement an appropriate seed banking strategy for the species. (USFWS, 2007)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated or completed over the next 5 years. Successful implementation of these actions will reduce threats to Chorizanthe orcuttiana and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Conduct additional discovery surveys of potential Chorizanthe orcuttiana habitat. 2. Enhance habitat where Chorizanthe orcuttiana occur, through nonnative plant control, erosion control, removal of excessive plant litter, selective trimming or removal of encroaching vegetation, and other appropriate measures. 3. Augment small occurrences (<1,000 individuals; CBI and AECOM 2021a, table 3.6-1) where necessary into areas of suitable habitat with a genetically appropriate seed source to increase population size and support gene flow. Follow best management practices for seed reintroduction as outlined in the Rare Plant Management Plan and the Seed Collection, Banking, and Bulking Plan (CBI and AECOM 2021a, pp. 253–294; CBI and AECOM 2021b, pp. 132–145) and IUCN Guidelines for Reintroductions and Translocations (IUCN/SSC 2013, entire). 4. Identify areas for habitat enhancement and conduct reintroduction of Chorizanthe orcuttiana to establish additional populations. 5. Prioritize additional research needs outlined in the SDMMP Rare Plant Management Plan (CBI and AECOM 2021a, pp. 293–294), with higher priority towards research that can directly inform species' management. For example: a. Research effects of fire and nonnative grasses and forbs on Chorizanthe orcuttiana fitness. b. Investigate effects of grass-specific herbicide on Chorizanthe orcuttiana to assess efficacy for controlling nonnative grasses in C. orcuttiana habitat. c. Determine viability rates of wild-collected and first-generation bulked seed to assess variability. (USFWS, 2021)

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# SPECIES ACCOUNT: *Chorizanthe pungens var. hartwegiana* (Ben Lomond spineflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/07/1994; Pacific Southwest (R8)

**Physical Description**

a small annual herb in the buckwheat family (Polygonaceae). The plants grow up to 2.5 decimeters (10 inches) high. Whorls of bracts (involucres) below the flowers are 1.5—2.5 millimeters (0.6—1.0 inch) long and have pink scarious (thin and dry) margins. The tepals (undifferentiated petals and sepals) are irregularly toothed at the tips. Compared to other species in thepungens-robusta complex, Ben Lomond spineflower is more erect and the flower clusters and associated structures (infloresences) are pink with small distinct heads (Ertter 1996). (USFWS, 1998)

**Taxonomy**

Chorizanthe pungens was first described by George Bentham in 1836 based on a specimen collected in Monterey. This taxon was recognized by George Goodman in 1934 as the type species in describing the Pungentes section ofthe genus. Chorizanthe pungens var. hartwegiana was distinguished from C. pungens var. pungens by James Reveal and Clare Hardham (1989) based on a distinction between the coastal form and an inland form “in the Ben Lomond sandhills area.” (USFWS, 1998)

**Historical Range**

See current range/distribution.

**Current Range**

Monterey and San Luis Obispo counties, CA. (USFWS, 2912)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2007)

**Breeding Season**

Adult: Chorizanthe pungens var. hartwegiana seeds germinate in the late fall after the first substantial winter rains. The plants remain small through the winter, then grow quickly and begin producing flowers in April. The length of the flowering season may persist for several months if the climatic conditions during the spring and early summer are favorable (USFWS, 2007).

**Reproduction Narrative**

Adult: Chorizanthe pungens var. hartwegiana seeds germinate in the late fall after the first substantial winter rains. The plants remain small through the winter, then grow quickly and begin producing flowers in April. The length of the flowering season may persist for several months if the climatic conditions during the spring and early summer are favorable. Flowers are pollinated by a variety of insects, including wasps, bees, flies, and butterflies (Morgan 1997 in Service 1998). Seed set varies with site conditions; in controlled experiments with plants transplanted into grass, manzanita, and pine sites, seed set varied from none to about 60 seeds per plant. Higher seed set was closely tied to the lack of shading (Kluse 1994) (USFWS, 2007). This taxon is a short-lived annual species which undergoes large variations in population numbers from year to year depending on climatic conditions and other factors (USFWS, 2007). First-year and, frequently, second-year plants consist ofa basal rosette. In subsequent years, the basal roseffe withers as the main flowering stem develops. In Erysimum species, flowering may be postponed due to unproductive habitat; therefore, some adults may be older than two years old. Successful reproduction most likely depends on habitat characteristics and climatic conditions (Berg 1986) (USFWS, 1998).

**Habitat Type**

Adult: Ponderosa pine woodland (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Restricted to pockets of sandstone-derived coarse sandy soils - uplifted ancient marine terraces persisting in a mountain range of volcanic origin. These coarse sands create drier soil conditions than those in the surrounding substrates and support an unusual, open, park-like ponderosa pine woodland community. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species specific habitat requirements and low number of known populations.

***Dispersal/Migration***

**Dispersal**

Adult: Seeds dispersed by large mammals (mule deer, coyotes, rabbits) and small mammals (on their fur). Insects also disperse seed (USFWS, 2012).

**Dispersal/Migration Narrative**

Adult: Seeds are dispersed by mule deer (Oidocoileus hemionus), coyotes (Canis latrans), rabbits (Sylvilagus spp.), and small mammals that come into contact with the plants in late June and July (McGraw 2004b). At that time, the seeds, which are contained in spiny involucres, are easily separated from the flower stems and adhere to the coats of mammals (McGraw 2004b). Insects, including ants, carry out secondary dispersal of those seeds that fall to the soil in late summer (McGraw 2004b). Dense patches of seedlings below the parent plant, however, suggest that many seeds are not widely dispersed (McGraw 2004b). With seeds viable only up to 1 year after production, and with germination less than 0.01 percent, there is little evidence to suggest that Chorizanthe pungens var. hartwegiana has an extensive seed bank (McGraw 2004b). New information concerning the soil seed bank of the closely related Chorizanthe pungens var. pungens was published in 2006 (Fox et al. 2006). This 5-year study found that the density of Chorizanthe pungens var. pungens in a population was directly related to the previous year's seed set, and that the species germinates well under most winter conditions and does not develop an extensive persistent soil seed bank (USFWS, 2012).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2012)

**Number of Populations:**

21 (USFWS, 2022)

**Population Narrative:**

1-5 current EOs. (NatureServe, 2015). Population trends are unknown and will be difficult to monitor do to natural yearly fluctuations in populations (USFWS, 2012). Low resiliency, representation and redundancy are inferred based on the low number of known populations, specific habitat requirements and relatively small geographic area in which the species is known to occur. There are currently 21 known populations (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Private development (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Private development was occurring on a limited scale within the habitat of the species at the time of listing, and is still occurring at low levels. Between 1993 and 1998, urban development has resulted in the loss of over 480 hectares (194 ha) of sandhills habitat (Service 1998). Construction of private homes, roads, and businesses has removed vegetation and modified soils through excavation, compaction, and disruption of soil horizons (Service 1998). Recent private development has had only a limited effect on the overall habitat and range of the species. One of the secondary effects of destruction and fragmentation of habitat by urban development is the introduction, either intentionally or inadvertently, of non-native plants to adjacent remaining habitat (USFWS, 2012).

**Stressor:** Recreational threats (USFWS, 2012)
**Exposure:**

**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** Recreational threats identified in the Recovery Plan, including hiking, equestrian use, off-road vehicles, mountain biking, and camping, have resulted in habitat degradation and fragmentation (Service 1998; McGraw 2004b). Mountain bikes and off-highway vehicles continue to pose the greatest recreational threats to sensitive habitat, and have caused extensive damage to suitable habitat - specifically at Henry Cowell Redwoods State Park (McGraw, in litt. 2011). These activities crush and remove vegetation, compact soils, promote soil erosion, and can occasionally result in oil and gasoline spills. Equestrian use, mountain biking, motorcycles and social gatherings that can include bonfires remain ongoing impediments to recovery of the species at Olympia Wellfield and Quail Hollow Quarry (C. Mitcham, in litt. 2011; McGraw 2009b). There is also evidence of people accessing Quail Hollow Quarry for games of paintball (McGraw 2009b). These factors continue to threaten the existence of this species and remain relatively unaddressed at this time (McGraw 2004b; McGraw, in litt. 2011) (USFWS, 2012).

**Stressor:** Increased vegetation cover (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Increased vegetation cover resulting from fire exclusion was not identified as a major threat at the time of listing, but is one of the most serious ongoing threats to the persistence of Chorizanthe pungens var. hartwegiana (McGraw 2004b; McGraw, in litt. 2011; T. Hyland, pers. comm. 2011). Encroachment by woody species and litter buildup, in large part stemming from the disruption of natural fire cycles, encourages habitat type conversion (McGraw 2004b). The exclusion of wildfires from sandhill communities results in longer intervals between fire events, and in the sand parkland and northern maritime chaparral communities, this has resulted in increased vegetation cover and heightened competition for space with other species over time. Increased shading due to abundant vegetation cover also may reduce the quality of the habitat for this species. Chorizanthe pungens var. hartwegiana has the potential to benefit from fire, but little is known about the fire regime to which it is adapted. Ongoing modifications to the sandhills habitat, including widespread invasive species and non-native annual grasses, may impact how Chorizanthe pungens var. hartwegiana interacts and responds to fire (McGraw 2009b). Furthermore, fire suppression methods, including application of fire retardant, foam, and large amounts of water, can influence how Chorizanthe pungens var. hartwegiana will recover after a fire, and they may affect the surrounding community assemblage by fertilizing the sandy soil and perhaps providing a competitive advantage to non-native annual grasses and other invasive species (McGraw 2009b) (USFWS, 2012).

**Stressor:** Disease or Predation (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals (USFWS, 2012)
**Narrative:** Disease and predation were not identified as factors at the time of listing, and are not known to currently be factors. Limited herbivory by lepidopteran larvae (caterpillars) on Chorizanthe pungens var. hartwegiana rosettes and mammalian herbivory on seedlings were personally observed by Jodi McGraw, but do not seem to have a detrimental effect on overall seedling survivorship (McGraw 2004b) (USFWS, 2012).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Given the existing regulations, we have seen some benefit from the Federal and County regulations to Chorizanthe pungens var. hartwegiana. Several HCPs have been implemented by private landowners, who are required to mitigate the effects that their actions have on Chorizanthe pungens var. hartwegiana. The existing regulations can only prevent habitat loss if the HCP requires that landowners avoid habitat or restore degraded habitat (USFWS, 2012).

**Stressor:** Fire Exclusion (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Although not indicated at the time of listing, fire exclusion in Santa Cruz County was leading to encroachment by native woody species and non-native annual grasses threatening habitat type conversion and loss of suitable habitat for Chorizanthe pungens var. hartwegiana. Fire exclusion allows for the accumulation of understory litter and the establishment of plants with which Chorizanthe pungens var. hartwegiana cannot compete for light. The result from fire exclusion is a reduction in sand parkland habitat for the Chorizanthe pungens var. hartwegiana (McGraw 2004b). Chorizanthe pungens var. hartwegiana experiences reductions in population size as a result of competition with exotic species for open habitat (McGraw 2004b). Research was completed by McGraw (2004b) on various habitat management strategies, including the use of prescribed fire and manual clearing. Management efforts aimed at restoring Chorizanthe pungens var. hartwegiana habitat should apply these research findings (USFWS, 2012).

**Stressor:** Stochastic Extinction (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Extinction
**Narrative:** Due to its small population and restricted habitat within a narrow geographic range, Chorizanthe pungens var. hartwegiana is vulnerable to stochastic extinction (Service 1994; McGraw and Levine 1998). Typically, annuals and other monocarpic plants (individuals that die after flowering and fruiting), such as Chorizanthe pungens var. hartwegiana, are vulnerable to random fluctuations or variation (stochasticity) in annual weather patterns and other environmental factors (Huenneke et al. 1986). A small population size may make it difficult for a species to persist while sustaining other impacts such as habitat alteration that favors non-native species (USFWS, 2012).

**Stressor:** Climate Change (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). Chorizanthe pungens var. hartwegiana’s small and isolated range increases

its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as can be brought about by climate change. Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on climate modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" to higher elevations and northward, depending on the ability of each species to do so. In the case of the sandhills ecosystem, which is limited to specific soil types in Santa Cruz County, the opportunities to move to higher elevations or further north are limited. Chorizanthe pungens var. hartwegiana's presence at relatively high elevations (90-610 meters (295-2000 feet)) does not make it immediately vulnerable to sea level rise; however, it is susceptible to an altered hydrological regime if changes in the annual precipitation schedule or fog patterns occur. The species requires full access to the sun to survive and reproduce, and an increase in fog cover or too much precipitation can reduce the reproductive capacity of the plant to unsustainably low levels. In general, the scientific community lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect species like Chorizanthe pungens var. hartwegiana. Small-ranged species, such as Chorizanthe pungens var. hartwegiana, however, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2012).

**Stressor:** Nitrogen Deposition (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The coarse nature of Zayante soils contributes to this sandy substrate generally having low moisture and nutrient availability. Traditionally, nitrogen can be one of the limiting nutrients in the sandhills, and increased nitrogen deposition from air pollution and urbanization can threaten the biodiversity of the ecosystem (Weiss 1999). Chorizanthe pungens var. hartwegiana could be impacted by increased nitrogen deposition, resulting primarily from the combustion of fossil fuels. Nitrogen can fertilize non-native annual grasses, such as rattlesnake grass (Briza maxima), rip-gut brome (Bromus diandrus), and rattail fescue (Vulpia myuros), which exert strong competitive effects on Chorizanthe pungens var. hartwegiana (McGraw 2004a). Competition with nonnative plants poses the greatest threat to Chorizanthe pungens var. hartwegiana (Service 1998). At the Bonny Doon Ecological Reserve, the presence of the non-native annual grass Vulpia myuros was shown to significantly inhibit the growth and reproductive success of Chorizanthe pungens var. hartwegiana where they occur together (Pollock 1995) (USFWS, 2012).

***Recovery***

**Reclassification Criteria:**
1. The 21 currently known populations have been secured through fee-title acquisition, conservation easements, or Habitat Conservation Plans. (USFWS, 1998)

2. Conservation measures for this species are included in Habitat Conservation Plans (Graniterock Quarry, Kaiser Sand and Gravel Felton Plant, and the County of Santa Cruz) that have been developed and implemented for the listed insect species. (USFWS, 1998)

3. Management plans for populations on Quail Hollow Ranch County Park and the adjacent State-owned parcel, Bonny Doon Ecological Reserve, Henry Cowell Redwoods State Park, Big Basin State Park, and Gray Whale Ranch State Park are developed and being implemented. (USFWS, 1998)

4. Population numbers are stable or increasing. (USFWS, 1998)

Recovery Priority Number: 9

**Delisting Criteria:**
When the downlisting criteria have been met for a species the species can be considered for delisting if: 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. (USFWS, 1998)

**Recovery Actions:**
- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history. ecology, and population dynamics of these species that will contribute to appropriate management strategies Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)
- 6. Evaluate progress of recovery effectiveness of management and recoverv actions and revise management plans. (USFWS, 1998)

- Recommended Action from 2012 5-Year Review: Coordination of recovery partners and consolidation of occurrence data is critical to get a better overview of the current status of Chorizanthe pungens var. hartwegiana (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Increased Service oversight as time allows, may accelerate completion of the HCP with the County of Santa Cruz and other management plans under development at Big Basin State Park, Henry Cowell Redwoods State Park, Gray Whale Ranch State Park, Quail Hollow Ranch County Park, and Bonny Doon Ecological Reserve. These plans need to be completed before implementation and effective recovery efforts may begin (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Surveys and ongoing monitoring should be undertaken to ensure that potential populations are identified and reliable demographic information is collected. These efforts should focus on sandhills habitats identified as population occurrences to clarify whether and where management actions are necessary. In addition, the CNDDB records should be updated with the most current information available. Specifically, the areas listed in McGraw (2004) as West Lompico, Weston Road, Hilton Drive, Sunset Ridge, Marion, and Landfill Heights; Gray Whale Ranch State Park; and Henry Cowell State Park (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: More detailed knowledge of population occurrences and completion of management plans should allow active management to prevent encroachment of both native and nonnative species in fire-suppressed areas which may lead to type conversion of the habitat and potential extirpation of individual populations. Prescribed burns are the most natural way to restore the vegetation thinning needed to restore open habitat, but in many areas proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion and increased germination rates in Chorizanthe pungens var. hartwegiana seeds (McGraw, 2004). This method may be used in places where fire would create unacceptable risk to local communities (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted. These parties should be provided with information necessary to facilitate management of habitats on these holdings. These private efforts could prevent habitat type conversion due to encroachment by other species in fire suppressed areas, minimize unnecessary impacts, and could aid in maximizing the conservation potential of all suitable habitat and populations (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: The second criterion for downlisting in the recovery plan should be reworded. The criterion as currently worded lists specific HCPs by name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time and even requirements may change. These changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criterion should be avoided. A blanket statement reflecting the need of the species to be included in any HCP that covers its geographic area would be more appropriate (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Conduct surveys throughout the range of Ben Lomond spineflower to create a detailed and reliable map of occupied areas and suitable but unoccupied habitat. 2. Evaluate the presence and longevity of a seed bank at areas currently occupied, recently occupied, and historically occupied to better understand the need for supplemental seeding following habitat restoration. 3. Secure funding to support monitoring at all protected Ben Lomond spineflower locations (USFWS, 2022).

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# SPECIES ACCOUNT: *Chorizanthe pungens var. pungens* (Monterey spineflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 02/04/1994; California/Nevada (R8) (USFWS, 2015)

**Physical Description**

Monterey spineflower (Chorizanthe pungens var. pungens) is a small annual plant, typically prostrate, that may form dense mats. Individual plants have spreading stems 2 to 6 inches long with clusters of generally dense flowers appearing white to pink (USFWS, 2024).

**Taxonomy**

Accepted by Kartesz (1994 checklist and 1999 floristic synthesis) and Flora of North America (2005); however, not listed specifically as distinct at the varietal level by Hickman (1993). Results from a molecular study indicate that Chorizanthe pungens var. pungens and C. robusta var. robusta are more closely related to each another than to the other subspecific taxa in the C. pungens and C. robusta complex; however, more analysis is needed to determine how this would their taxonomic treatment (Brinegar 2006, Baron and Brinegar 2007, Brinegar and Baron 2008 cited by USFWS 2009). (NatureServe, 2015)

**Historical Range**

Based on a single collection from 1842, it may have also occurred historically in extreme northern San Luis Obispo County near San Simeon (Flora of North America Editorial Committee 2005; CNPS 2009). (NatureServe, 2015)

**Current Range**

Plants are typically found in open areas between perennial vegetation where sandy soil limits competition from other plants. Monterey spineflower occurs in Santa Cruz and Monterey Counties (USFWS, 2024).

**Critical Habitat Designated**

Yes; 1/9/2008.

**Legal Description**

On January 9, 2008, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for Chorizanthe pungens var. pungens (Monterey spineflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in California (73 FR 1525-1554). The 2008 Rule replaced critical habitat designated on May 28, 2002 (67 FR 37498-37546).

**Critical Habitat Designation**

The critical habitat designation for Chorizanthe pungens var. pungens includes nine CHUs in Santa Cruz and Monterey Counties, California. In total, approximately 11,055 acres (ac) (4,475 hectares (ha)) fall within the boundaries of this revised critical habitat designation (73 FR 1525-1554).

Unit 1: Sunset (85 ac (35 ha)): This unit consists of coastal beaches, dunes, and bluffs located west of Watsonville in southern Santa Cruz County. Unit 1 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils primarily in the coastal beach, dune land, and Baywood sand series (Soil Conservation Service 1978, pp. 13– 25; 1980 (maps)) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied (CNDDB 2006, California Department of Parks and Recreation (CDPR) 2006a). This unit consists exclusively of State land (85 ac (35 ha)) and is entirely within the boundaries of Sunset State Beach. The unit includes land from Sunset Beach Road south to the gate on Shell Road, just north of the mouth of the Pajaro River, and west of Shell Road, which extends the length of Sunset State Beach. Unit 1 is essential because it supports a large population of Chorizanthe pungens var. pungens that in some years numbers in the tens of thousands (CNDDB 2006; CDPR 2006a). The features essential to the conservation of the species may require special management considerations or protection in this unit due threats from invasive, nonnative plants, particularly European beachgrass, which forms dense stands on coastal beaches and crowds out C. p. var. pungens, and from recreational activities, including camping and foot traffic, which could trample plants.

Unit 2: Moss Landing (250 ac (101 ha)): This unit consists of coastal beaches, dunes, and bluffs to the north and south of the community of Moss Landing in northern Monterey County. Unit 2 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach and dune land series (Soil Conservation Service 1978, pp. 13–25) (PCE 1). The northern portion of this unit includes lands owned and managed by the State (which includes portions of Zmudowski State Beach and Moss Landing State Beach between the mouths of the Pajaro River and Elkhorn Slough), 20 ac (8 ha) of private lands, and 6 ac (2 ha) of county lands. The southern portion of this unit includes State lands within Salinas River State Beach. This unit was occupied at the time of listing (59 FR 5499) and was included in the previous critical habitat designation. Herbarium records indicate that this site was occupied as early as 1933, and has remained occupied through time (Consortium of California Herbaria 2006 cites collections by H.S. Tates 1936; T. Craig 1933; and J. Thomas 1950). Chorizanthe pungens var. pungens was also recently observed in this unit (CDPR 2006b, unpaginated). This unit contains one of only five populations found along the coast, and it may provide connectivity between the Sunset Unit to the north and the Marina Unit to the south. The features essential to the conservation of the species may require special management considerations or protection in this unit due threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out C. p. var. pungens, and from recreational activities including foot traffic, which could trample plants.

Unit 3: Marina (881 ac (357 ha)): This unit consists of coastal beaches, dunes, and bluffs ranging from just south of the mouth of the Salinas River, south to the city of Monterey in northern Monterey County; these lands are entirely west of Highway 1. Unit 3 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, dune land, and Oceano loamy sand soil series (Soil Conservation Service 1978, pp. 13–25, 54–55) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and it is currently occupied (CNDDB 2006; CDPR 2006; Service 2002, p. 54). Unit 3 is comprised of State lands, including Marina State Beach and Monterey State Beach. This unit is essential because it supports a population of Chorizanthe pungens var. pungens that numbers in the thousands in some years (CNDDB 2006; Service 1998,

p. 67); it is the southernmost of the Monterey Bay area coastal populations; and it may provide connectivity between the populations along the coast and the more interior populations found at former Fort Ord. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out C. p. var. pungens; recreational activities such as foot traffic, which could result in the trampling of plants; and edge effects of urban development.

Unit 4: Asilomar (48 ac (19 ha)): This unit consists of coastal dunes and bluffs near the communities of Pacific Grove and Pebble Beach on the Monterey Peninsula in northern Monterey County. This unit includes a portion of Asilomar State Beach, and extends just beyond Lighthouse Avenue to the north and terminates at the boundary of the Asilomar Conference Grounds. This unit's eastern boundary extends from Highway 68 north along Asilomar Avenue, and then turns west on Arena Avenue where the boundary connects to Sunset Drive. Unit 4 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, dune land, and Baywood sand soil series (Soil Conservation Service 1978, pp. 13–25) (PCE 1). This unit is comprised of 4 ac (1 ha) of Federal lands, 40 ac (16 ha) of State lands at Asilomar State Beach, and 4 ac (2 ha) of local government ownership. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. Herbarium records that contain specimens from this area include the following (collector and year): Lemmon 1881, L.C. Wheeler 1936, R. Hoover 1941 and 1963, and L.S. Rose 1963 (Consortium of California Herbaria 2006)). This unit currently supports a population of Chorizanthe pungens var. pungens that numbers in the hundreds (Moss 2000, unpaginated). This unit is essential because it is the southernmost of only five populations of C. p. var. pungens along the coast. Preserving the genetic characteristics that have allowed individuals at this site to survive at the southern end of the species' range along the coast is essential to the long-term survival and conservation of C. p. var. pungens. Protecting peripheral or isolated populations is necessary because they may contain genetic variation not found in core populations. The genetic variation results from the effects of population isolation and adaptation to locally distinct environments (Lesica and Allendorf 1995, pp. 754–757; Fraser 2000, pp. 49– 51; Hamrick and Godt 1996, pp. 291– 295). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out C. p. var. pungens; recreational activities such as foot traffic which could trample plants; and edge effects of urban development. An additional threat in this unit is the expansion of unregulated vehicle parking in the dunes associated with the high numbers of visitors this area receives each year.

Unit 5: Freedom Boulevard (24 ac (10 ha)): This unit consists of grassland, maritime chaparral, and oak woodland habitat near the western terminus of Freedom Boulevard and northeast of Highway 1 in Santa Cruz County. This unit consists entirely of private lands (24 ac (10 ha)). Unit 5 contains space for individual and population growth, including sites for seed dispersal and germination; provides for the basic requirements for growth; and includes soils in the Baywood sand and Ben Lomond sandy loam series (Soil Conservation Service 1980, pp. 64–65; maps) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied (CNDDB 2006, element occurrences (EOs) 32 and 34; Morgan 2006, unpaginated). This unit currently supports a population of Chorizanthe pungens var. pungens that numbers in the thousands in favorable years, but many fewer in unfavorable years (CNDDB 2006, EOs 32, 34). This unit is essential because it is the northernmost known occurrence. In the absence of genetic data, protecting populations at the boundaries of a taxon's range is necessary because they may contain genetic variation not found in core populations. The genetic variation results from the effects of population isolation and adaptation to locally distinct environments (Lesica and Allendorf 1995, pp. 754–757; Fraser 2000, pp. 49–51; Hamrick and Godt 1996, pp. 291–295). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly annual grasses that crowd out C. p. var. pungens, and from edge effects of urban development.

Unit 6: Manresa (94 ac (38 ha)): This unit consists of coastal bluffs along the immediate coast, south of Seacliff State Beach and north of Sunset State Beach in Santa Cruz County. Unit 6 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, Baywood sand, and Elder sandy loam series (Soil Conservation Service 1980, pp. 11–70, maps) (PCE 1). This unit is comprised entirely of lands owned and managed by the State at Manresa State Beach. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. This unit is essential because it is the most northerly population that is known from the immediate coast and provides connectivity to populations in the Sunset Unit to the south. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants and from recreational activities such as foot traffic, which could trample plants.

Unit 7: Prunedale (190 ac (77 ha)): This unit consists of grassland, maritime chaparral, and oak woodland in the area around Prunedale in northern Monterey County. On the west side of Highway 101, the unit includes the Manzanita County Park subunit located between Castroville Boulevard and San Miguel Canyon Road. On the east side of Highway 101, the unit consists of four additional subunits. The five subunits support similar plant communities and need similar types of special management; therefore, we discuss them as a unit. Unit 7 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the Arnold loamy sand, Santa Ynez fine sandy loam, and Arnold-Santa Ynez complex series (Soil Conservation Service 1978, pp. 9–11, 72–73) (PCE 1). This unit consists of 155 ac (63 ha) of State lands, 18 ac (7 ac) of local agency lands (Manzanita County Park), and 17 ac (7 ha) of Pacific Gas and Electric easement lands. This unit was occupied at the time of listing, was included in our listing rule in reference to the Prunedale area (59 FR 5499), and is currently occupied (Caltrans 2001; Consortium of California Herbaria 2006). This unit is essential because it is one of only four units that are known to support populations in maritime chaparral and oak woodland habitats more representative of hotter, interior sites and is the easternmost of the units in the interior hills. The features essential to the conservation of the species may require special management considerations or protections in this unit due to threats from invasive, nonnative plants, which crowd out Chorizanthe pungens var. pungens; edge effects from urban development; and recreational activities such as off road vehicles, which can crush plants and destroy seeds.

Unit 8: Fort Ord (9,432 ac (3,817 ha)): This unit consists of grassland, maritime chaparral, coastal scrub, and oak woodland on the former Department of Defense base at Fort Ord, east of the city of Seaside in northern Monterey County. This unit is entirely within the area formerly known as Fort Ord, bounded by Highway 1 on the northwest, the Salinas River to the east, and Monterey-

Salinas Road (Highway 68) on the south. Approximately 87 percent of this critical habitat unit is Federal land (8,172 ac (3,307 ha)) managed by BLM and the Army, 6 percent is State land (606 ac (245 ha)), and 7 percent is under local jurisdictions (654 ac (265 ha)). Portions of Fort Ord have been transferred to BLM; University of California, California State University at Monterey Bay; and local (city and county) jurisdictions. All of the lands included in this unit are designated as current or future habitat reserves under the Army's habitat management plan (Corps 1997, Attachment A map; Zander Associates 2002, Figures 4–6). About one-half of Unit 8 still must be cleaned of environmental contaminants by the Army before it can be transferred to BLM. Unit 8 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the Arnold-Santa Ynez complex, Baywood sand, and Oceano loamy sand series (Soil Conservation Service 1978, pp. 9– 73). Lands in this unit are intended to be managed at a landscape scale, using prescribed fire, as needed, to maintain a range of different-aged maritime chaparral stands (Corps 1997, pp. 4.24– 4.25), and by doing so preserve substantial populations of rare maritime chaparral species in the Monterey Bay area. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. This unit is essential because it currently supports multiple large populations of Chorizanthe pungens var. pungens that number in the tens of thousands in some years (CNDDB 2006, EO 2; Jones and Stokes 1992, Figure F– 3; BLM 2006), and it is one of only five units that include maritime chaparral and oak woodland habitats more representative of hotter, interior sites. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive species that crowd out C. p. var. pungens, munitions clean-up methods on former ranges that remove and chip all standing vegetation, and recreational activities and road and trail maintenance that could trample plants.

Unit 9: Soledad (51 ac (21 ha)): This unit consists of an interior dune in the floodplain of the Salinas River channel just south of the city of Soledad in central Monterey County on privately owned lands. Unit 9 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the dune land and Metz complex soil series (Soil Conservation Service 1978, pp. 24, 48–49) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. Approximately 5,000 plants were observed in this unit in 1994 (CNDDB 2006, EO 28; Wesco 1994, pp. 5–8). This unit is essential because it is the southernmost interior location that supports a population and the only unit where Chorizanthe pungens var. pungens grows in interior floodplain dune habitat. This population is geographically remote from all others in this revised critical habitat designation. Protecting peripheral or isolated populations of rare species is highly desirable because they may contain genetic variation not found in core populations (Lesica and Allendorf 1995, pp. 755–757). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, which crowd out C. p. var. pungens; overspray of herbicides and pesticides from agricultural operations; and vegetation clearing activities associated with road maintenance.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The primary constituent element of critical habitat for Chorizanthe pungens var. pungens (73 FR 1525-1554) is a vegetation structure arranged in a mosaic with openings between the dominant elements (e.g., scrub, shrub, oak trees, or clumps of herbaceous vegetation) that changes in spatial position as a result of physical processes such as windblown sands and fire and that allows sunlight to reach the surface of the following sandy soils: coastal beaches, dune land, Baywood sand, Ben Lomond sandy loam, Elder sandy loam, Oceano loamy sand, Arnold loamy sand, Santa Ynez fine sandy loam, Arnold—Santa Ynez complex, Metz complex, and Metz loamy sand.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, and roads) and the land on which such structures are located, existing within the legal boundaries on the effective date of this rule.

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: March to June (USFWS, 2009)

**Reproduction Narrative**

Adult: Chorizanthe pungens var. pungens is a prostrate annual species in the buckwheat family (Polygonaceae). Flowering occurs from late March to June, depending on weather patterns, and seed is dispersed in mid-summer. Chorizanthe pungens var. pungens plants produce a maximum of one seed per flower and, depending on the vigor of the plant, produce dozens of seeds per plant (Fox et al. 2006). (USFWS, 2009)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest Edge, Forest/Woodland, Grassland/herbaceous, Old field, Sand/dune, Savanna, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Mild maritime climate, characterized by fog and winter rains (USFWS, 1998)

**Geographic or Habitat Restraints or Barriers**

Adult: Found in open areas: openings between shrubs, roadsides, firebreaks, and a heavily disturbed firing range. (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Scattered (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from USFWS, 2009)

**Habitat Narrative**

Adult: Chorizanthe pungens var. pungens is found scattered on sandy soils within coastal and near-coastal dune, coastal scrub, grassland, maritime chaparral, and oak woodland communities. Found in open areas: openings between shrubs, roadsides, firebreaks, and a heavily disturbed firing range. This plant occurs in areas of relatively mild maritime climate, characterized by fog and winter rains. The fog helps keep summer temperatures cool and winter temperatures relatively warm, and provides moisture in addition to the normal winter rains. Other plants associated with this species include beach-bur (Ambrosia chamissonis), coastal sagewort (Artemisiapycnocephala), and mock heather (Ericameria ericoides). (USFWS, 1998; NatureServe, 2015)

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (inferred from USFWS, 2009)

**Dispersal**

Adult: High (inferred from USFWS, 2009)

**Dependency on Other Individuals or Species for Dispersal**

Adult: Animals (USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: Seed dispersal in C. p. var. pungens is likely facilitated by hooked spines on the structure surrounding the seed. In the Chorizanthe genus, these are believed to attach to passing animals and disperse seeds between plant colonies and populations (Reveal 2001). Wind also likely disperses seeds within colonies and populations. (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

Declining

**Number of Populations:**

51 CNDDB occurrences (USFWS, 2024)

**Population Size:**

~ 2,000,000 across all occurrences (USFWS, 2024)

**Adaptability:**

Moderate (USFWS, 2009)

**Population Narrative:**

Approximately 18 occurrences observed since 1989 (CNDDB 2008). Populations in the hills between Watsonville and Aptos are small, declining, and have been impacted by developments throughout the 1990s (Hayes and Taylor 2006). C. pugens var. pugens has the ability to recolonize sites when invasive plants are removed if there is a seed source (USFWS 2009). The original survey used large blocks of habitat and the calculations included closed canopy blocks of woody vegetation. The reduction in estimated occupied habitat yields a population between 200,000 and 2,000,000 individuals. (USFWS, 1998; USFWS, 2009; NatureServe, 2015). At the time of listing, we knew of Monterey spineflower occurrences in sand dunes along the coast between Manresa State Beach and the Monterey Peninsula, in Manzanita Park in the Prunedale Hills, throughout the former Fort Ord, and in historical collections from Soledad and San Simeon (Service 1994, 59 FR 5500). We estimated the population size to be approximately 2 million individuals across seven occurrences (Service 1998, p. iii). Between the time of listing in 1994 and the publication of the Recovery Plan in 1998, the number of occurrences had increased to 26 (Service 1998, pp. 66-67). By 2009, 29 occurrences had been described (Service 2009, pp. 5, 18). Currently, the California Natural Diversity Database (CNDDB) lists 51 occurrences with no changes since the 2020 5-year review (CNDDB 2024a, data). Unprocessed data from the CNDDB online field survey form shows 11 submissions not currently in the CNDDB (CNDDB 2024b, data). Ten of these submissions are likely to provide updated information for existing occurrences and each show that the occurrences are extant. One submission may become a new occurrence at the northeastern range of the species in the Santa Cruz Mountains. Unpublished data from Caltrans suggests that the species may be more common in the eastern portion of its known range east of Prunedale (Caltrans 2004, data). These locations are also not represented in the CNDDB. The available information suggests the species is more widespread than was known at listing . Of the 51 CNDDB occurrences, 21 (41 percent) occur on land that is owned and managed by an entity with conservation objectives (e.g. California State Parks, Elkhorn Slough Foundation, The Nature Conservancy, federal lands, and others). The remaining 30 occurrences (59 percent) occur on mostly private land.(USFWS, 2024).

***Threats and Stressors***

**Stressor:** Development for residential, commercial and industrial uses (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Conversion of lands for urban development continues in the Monterey Bay area. Development projects have been proposed or approved in the last 5 years that would remove or fragment habitat of Chorizanthe pungens var. pungens in the Prunedale Hills (e.g., the Prunedale Improvement Project, Pesante Canyon developments), coastal region (e.g., at Armstrong Ranch, Monterey Airport), and on the Monterey Peninsula (e.g., at Pebble Beach) (Lowe 2001, Monterey County 2005, California Department of Transportation (Caltrans) 2005, City of Marina 2007, Rana Creek Habitat Restoration 2007). Development is also planned within the boundaries of the 28,000-acre former Fort Ord military base in Monterey County. On former Fort Ord, Chorizanthe pungens var. pungens is found in maritime chaparral, coastal sage scrub, and in openings in oak woodland. It occurs on parcels designated for development and habitat reserve, as well as in the margins of areas to be redeveloped. (USFWS, 2009)

**Stressor:** Recreation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Chorizanthe pungens var. pungens requires open sandy habitat in which to grow, so it consequently colonizes openings along roads and trails and may colonize trail beds, if use is infrequent. In at least one State Park site, at Sunset State Beach where recreational use was previously heavy, new barriers have been introduced to funnel recreational traffic and allow C. p. var. pungens to expand into the area from nearby occurrences (State Parks 2006a). Grading of trails (e.g., at former Fort Ord) may also diminish populations. However, on Fort Ord Public

Lands, BLM hopes to maintain adequate open space along the margins of trails and thereby retain trail use by people and continued occupancy by C. p. var. pungens along trail margins (BLM 2003). It appears that light recreational use, such as foot traffic, maintains more open habitat suitable for C. p. var. pungens, but excludes the taxon where traffic is frequent during the growing season. (USFWS, 2009)

**Stressor:** Dune stabilization (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Non-native species were introduced for dune stabilization and subsequently, compete for habitat with C. pungens var. pugens. (USFWS, 2009)

**Stressor:** Land ownership (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The dune scrub habitat of Chorizanthe pungens var. pungens is protected from development at numerous coastal locations. In Santa Cruz County, populations occur at Sunset State Beach and Manresa State Beach. In Monterey County, coastal populations occur along the Monterey Bay on preserved lands at Zmudowski, Moss Landing, Salinas River, Marina, Monterey, and Asilomar State Beaches, the latter of which is on the Monterey Peninsula near the southern end of this taxon’s extant range (Moss 2000, State Parks 2006b, CNDDB 2007). The interior occurrences in Santa Cruz County (e.g., Freedom Boulevard and Bel Mar areas (Service 2002: 67 FR 37498)), which are not discussed in the specific recovery criteria above, are not secure from development. In northern Monterey County in the Prunedale Hills, populations occur on easements owned by Pacific Gas and Electric, on private lands, on lands owned or managed by conservation-oriented organizations such as the Elkhorn Slough Foundation, at a County Park, and on State lands managed by the California Department of Transportation (Caltrans). The eventual use of the Caltrans land has not been determined (Siepel pers. comm. 2004; Robison 2006). Chorizanthe pungens var. pungens also occurs at numerous places on former Fort Ord, a closed military base and Superfund site that is being cleaned and planned for reuse. The population in a river dune near Soledad is privately owned and represents the southernmost interior population known to be extant. (USFWS, 2009)

**Stressor:** Invasive non-native species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The final rule identifies competition from invasive nonnative species, such as the iceplants (sea-fig) (Carpobrotus edulis, Mesembryanthemum crystallinum), and European beach grass (Ammophila arenaria), as a threat to this taxon (59 FR 5499). These species are particularly adept at colonizing dune sands and several of them have been used in California to promote dune stabilizations (Albert 2000). Invasive nonnative species remain a threat to Chorizanthe pungens. var. pungens. In addition to the species noted in the final rule, others that have invaded maritime chaparral and coastal sage scrub where C. p. var. pungens occurs include jubata grass (Corterderia jubata), French broom (Genista monspessulana), and invasive annual grasses of European origin, such as wild oats (Avena sp.), soft chess (Bromus hordeaceus), and ripgut brome

(Bromus diandrus) (BLM 2003, Parsons 2004, Fusari and McStay 2007). These latter species are typically able to colonize disturbed sites with more well-developed soils than occur on dunes. In addition to the direct effects that invasive, non-native plant species may have on Chorizanthe pungens var. pungens, Chorizanthe species may be indirectly affected by these species via diminished pollinator visitation. Many of the hymenopteran pollinators important to Chorizanthe pollination (e.g., sphecid wasps, bumblebees, and bees from the families Halictidae and Anthophoridae), require bare ground for nesting (Murphy 2003). (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Beaches along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The extent to which such events are caused by climate change and the extent to which it could affect Chorizanthe pungens var. pungens are unknown at this time. (USFWS, 2009)

**Stressor:** Agricultural Land Conversion
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Aerial imagery suggests that nine of 51 occurrences (18 percent) have been developed or converted to agriculture, but the amount of acres or number of individuals affected cannot be determined without survey data. Currently, there is very little land where Monterey spineflower occurs that could be converted to agriculture. We expect that the threat of agricultural land conversion will continue to decrease with time because coastal populations are not subject to agricultural conversion and the majority of inland suitable habitat occurs on the former Fort Ord where conversion to agriculture is not planned. (USFWS, 2020)

**Stressor:** Sand Mining
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A sand extraction operation was run on a portion of sand dunes and beach between Marina State Beach and the Salinas National Wildlife Refuge from 1986 through 2013 (CCC 2017, Exhibit 5, p. 3). The effect of this operation was the loss of approximately 243,000 cubic yards/year of sand from the Southern Monterey Bay littoral cell resulting in causing or worsening shoreline retreat and dune erosion (CCC 2017, Exhibit 5, p. 3). A settlement agreement in 2017 closed the operation and initiated reclamation of the extraction operation (CCC 2017, Appendix A, entire). Under the settlement agreement, removal of extraction equipment and facilities, and regrading and restoration will occur between 2020 and 2025 (CCC 2017, Appendix A, pp. 33-37). The closure of the sand extraction operation is likely to result in greater amounts of sand deposition on beaches within the range of the Monterey spineflower and reduce effects of shoreline retreat and coastal erosion. If the settlement agreement timeline is adhered to, sand mining will no longer be a threat to individuals or habitat of Monterey spineflower. (USFWS, 2020)

**Stressor:** Recreation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recreation from hiking, biking, equestrian, or other activities may create open space that can provide habitat for Monterey spineflower. However, sustained use of open areas is not likely to support the species because of direct damage to plants through trampling, erosion along trail systems, and introduction of invasive species that compete with Monterey spineflower. Recreation had historically been a threat at Sunset State Beach, but has been reduced through fencing that directs the impacts of recreational use to areas not occupied by Monterey spineflower (Service 2009, p. 8). It is possible that as the former Fort Ord becomes more open to the public that recreational use will increase and potentially impact Monterey spineflower. (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 15

**Delisting Criteria:**
1. The Fort Ord disposal and reuse process has led the management agencies to develop, fund, and implement permanent protection plans for the species' habitat including permanent iceplant suppression programs. (USFWS, 2009)

2. Beach-dune occurrences on State Park and private lands throughout its current range from Santa Cruz to the Monterey Peninsula are covered under a permanent protection plan. Plans at the time of writing to conserve roughly 60 percent of Fort Ord appear sufficient for recovery of the interior occurrence. A reassessment would be made should plans call for conservation of less habitat. Existing management along the coast at the State Parks units needs to be supplemented with protection and management on private lands to be determined after a thorough analysis of the beach populations. (USFWS, 2009)

3. Populations in the protected areas are stable or increasing over a 15 year period, which will include wet and drought years. (USFWS, 2019)

**Recovery Actions:**
- Protect habitat of the listed species and their occurrences on private lands by informing landowners and consulting with local lead agencies (USFWS, 1998)
- Minimize threats to the plants by minimizing the threats from invasive non-native plants and threats on private and public lands. (USFWS, 1998)
- Develop management strategies through a research program to document the listed species' life histories and their responses to vegetation management. (USFWS, 1998)
- Develop and implement management practices for the occurrences and habitat of Chorizanthe pungens var. pungens by establishing a working group to collaborate with private and public landowners and appropriate agencies to develop specific management

guidelines. (USFWS, 1998)

- Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria including trends, effectiveness of reduce threats, and survey likely habitat for additional occurrences.
- Coordinate recovery actions to protect other listed species and species of special concern.
- Develop and implement an outreach program
- The criteria should be revised to identify the importance of having protected populations in the interior north (Santa Cruz) and central (Prunedale Hills) portions of this taxon's range.
- Encourage the State to establish a permanent protection and management mechanism for the Caltrans managed lands in the Prunedale Hills.
- Continue to support and partner with organizations, agencies, and individuals to preserve, restore, and enhance lands on which this taxon occurs.
- Develop a Memorandum of Understanding or coordinate with land managers on other mechanisms (e.g., a set of management actions within a management plan) that would meet the recovery criterion of ensuring adequate management (primarily control of nonnative species and maintaining openings in native vegetation) on lands that support Chorizanthe pungens var. pungens.
- The current recovery criteria call for 15 years of monitoring. Coordinate with land managers to determine the most efficient means to implement and document adequate monitoring to ensure that the general trend or persistence of the populations is being tracked. Focus surveys and monitoring in years of high rainfall when the extent of its distribution is most likely to be apparent.
- Evaluation of Recovery Criteria 1. The Fort Ord Reuse Authority rescinded their application for a state incidental take permit and federal HCP in 2020. The 1997 Habitat Management Plan guides development and use of the former Fort Ord in the absence of a permanent protection plan and projects are evaluated as they arise. As a result, there is no unified plan for the permanent protection, monitoring, or management of Monterey spineflower throughout the former Fort Ord. 2. A majority of beach dune occurrences occur on protected land (California State Parks), but there is no permanent or range-wide protection or monitoring plan. 3. There is no range wide monitoring program that has 15 years of data by which to evaluate population trends. Population data is sparse throughout the range, and areas that do have some amount of continuous data are usually smaller portions of large parcels, such as the former Fort Ord (Service 2020, p. 8). Data that have been collected within an occurrence, but not part of a monitoring plan designed to represent the entire occurrence, should not be used to evaluate the stability of Monterey spineflower throughout the whole occurrence (USFWS, 2024).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-year review: • A range wide monitoring program should be created in order to evaluate occurrences of Monterey spineflower that are deemed essential to the recovery of the species. • Monitoring of Monterey spineflower populations on California State Beaches and the former Fort Ord should begin with the goal of having continuous long-term monitoring that will meet the intent of the stated recovery criteria. • Restoration and reintroduction should be attempted in coastal dune systems where past disturbance or invasive species have inhibited establishment of Monterey spineflower. • The taxonomy of the varieties of Chorizanthe pungens and Chorizanthe robusta should be reevaluated to determine if revisions are necessary or warranted. • The recovery criteria should be revisited to evaluate the importance of having protected populations in the interior north (Santa Cruz) and central (Prunedale Hills) portions of this taxon's range. (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS: In the 2020 5-year review, we recommended the following actions, which remain valid for this 5-year review: • A range wide monitoring program should be created in order to evaluate occurrences of Monterey spineflower that are deemed essential to the recovery of the species. • Monitoring of Monterey spineflower populations on California State Beaches and the former Fort Ord should begin with the goal of having continuous long-term monitoring that will meet the intent of the stated recovery criteria. • Restoration and reintroduction should be attempted in coastal dune systems where past disturbance or invasive species have inhibited establishment of Monterey spineflower. • The taxonomy of the varieties of Chorizanthe pungens and Chorizanthe robusta should be reevaluated to determine if revisions are necessary or warranted. • The recovery criteria should be revisited to evaluate the importance of having protected populations in the interior north (Santa Cruz) and central (Prunedale Hills) portions of this taxon's range (USFWS, 2024).

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# SPECIES ACCOUNT: *Chorizanthe robusta var. robusta* (Robust spineflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 02/04/1994; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

Chorizanthe robusta var. robusta is an annual spineflower in the Pungentes section of the genus Chorizanthe in the buckwheat family (Polygonaceae) (Figure 1). Like other spineflowers, it is branched from the base and subtended by a rosette of basal leaves. The plant has an erect to spreading or prostrate habit, usually standing not more than 20 cm (8 in high). The whorl of bracts subtending the flowers (involucres) has thin white to pinkish scarious (thin and translucent) margins along the basal portions of the teeth. Relative to other spineflower taxa in the Pungentes section, the flower heads are large (1.5 to 2.0 cm in diameter and distinctly aggregate. (USFWS, 2004)

**Taxonomy**

Accepted by Kartesz (1994 checklist and 1999 floristic synthesis) and Flora of North America (2005). However, Hickman (1993) does not list this taxon as distinct. Results from a molecular study indicate that Chorizanthe pungens var. pungens and C. robusta var. robusta are more closely related to each another than to the other subspecific taxa in the C. pungens and C. robusta complex; however, more analysis is needed to determine how this would their taxonomic treatment (Brinegar 2006, Baron and Brinegar 2007, Brinegar and Baron 2008 cited by USFWS 2009). (NatureServe, 2015)

**Historical Range**

Occurrences of Chorizanthe robusta var. robusta populations have been recorded since the late 1800s, occurring as far north as San Francisco and Alameda Counties, and south into Monterey County.  Inland occurrences were documented in and around San Jose and Los Gatos in Santa Clara County.  Coastal and near coastal occurrences have been documented in San Mateo County and Santa Cruz County where it is found today (CNDDB). (USFWS, 2010)

**Current Range**

Currently, there are 11 populations in Santa Cruz County over a range of approximately 21 miles (33.8 km). (USFWS, 2010)

**Critical Habitat Designated**

Yes; 5/28/2002.

**Legal Description**

On May 28, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chorizanthe robusta var. robusta (Robust spineflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (67 FR 36822-36845).

**Critical Habitat Designation**

The critical habitat designation for Chorizanthe robusta var. robusta includes six CHUs in Santa Cruz County, California. This species critical habitat encompasses approximately 469 acres (ac) (190 hectares (ha)) (67 FR 36822-36845).

Unit A: Pogonip Unit: Unit A consists of sandy openings within mixed forest habitat within Pogonip Park in the City of Santa Cruz. Of the 64 ha (159 acre) unit, 62 ha (152 ac) are owned and managed by the City; and the remainder are privately owned. As of the year 2000, two colonies comprising approximately 800 individuals occupied this site. This unit is important to the conservation of the taxon because it supports extant colonies of Chorizanthe robusta var. robusta. This unit also includes habitat that is important for the expansion of existing colonies and connectivity between the two colonies. In addition, it is also important because, aside from the Wilder Creek location which we were not aware of at the time of the proposed rule, Pogonip Park is the most northerly and westerly location known for the species. It is also one of only three known locations where C. r. var. robusta is found more than 5 km (3 mi) away from the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions may be important for the long-term survival and conservation of C. r. var. robusta.

Unit B: Branciforte Unit: Unit B consists of an old field/ grassland unit within the city limits of Santa Cruz. The 4-ha (9-ac) unit is privately owned. As of the year 2001, this unit supported a Chorizanthe robusta var. robusta population of approximately 500 individuals. This unit also includes habitat that is important for the expansion of the existing population. This unit is important to the conservation of the species because it contains one of the only eight known locations of C. r. var. robusta. It is the only other unit in close proximity to Unit A

Unit C: Aptos Unit: Unit C consists of sandy openings within maritime chaparral. The 28 ha (70 ac) unit is comprised entirely of private lands. As of the year 2000, this unit supported a Chorizanthe robusta var. robusta population of approximately 3,000 individuals. This unit also includes habitat that is important for the expansion of the existing population. It is also one of only three locations that supports C. r. var. robusta more than 5 km (3 mi) away from the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions (i.e., more inland conditions) may be important for the long-term survival and conservation of C. r. var. robusta.

Unit D: Freedom Unit: Unit D consists of grasslands and sandy areas in openings within maritime chaparral and oak woodland. This 4 ha (9 ac) unit is comprised of private and Pajaro Unified School District lands. As of the year 2001, this unit supports a Chorizanthe robusta var. robusta colony of several hundred individuals. Additionally, other colonies of C. r. var. robusta occur within a few hundred yards of the first colony; these additional colonies are outside the critical habitat boundary. This unit is important to the conservation of the taxon because it supports one of only eight known extant locations of C. r. var. robusta. This unit also includes habitat that is important for the expansion of the existing colony and connectivity between the two colonies.

Unit E: Buena Vista Unit: Unit E consists of grasslands within maritime chaparral and oak woodland on the Buena Vista parcel. The 55 ha (135 ac) unit is comprised entirely of private lands. As of 1999, this unit supports multiple colonies of Chorizanthe robusta var. robusta comprising approximately 1,500 individuals. This unit is important to the conservation of the species because it is one of only two units that supports multiple extant colonies of C. r. var.

robusta. This unit also includes habitat that is important for the expansion of the existing colonies, and connectivity between the multiple colonies.

Unit F: Sunset Unit: Unit F consists of coastal dune habitat, and is identical to critical habitat that is being designated for the Chorizanthe pungens var. pungens. All of this 35 ha (86 ac) unit is within Sunset State Beach. As of 2001, this unit supports the largest concentration of C. r. var. robusta, including dozens of colonies of comprising tens of thousands of individuals. This unit is important to the conservation of the species because it is only one of two units that supports multiple extant colonies of C. r. var. robusta. This unit also includes habitat that is important for the expansion of these existing colonies into areas that were historically occupied, and for maintaining connectivity between the multiple colonies. The unit is also important because it is the most southerly location known for the species and the only location, aside from Manresa State Beach which was not proposed for critical habitat, where C. r. var. robusta is found so close to the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions (i.e., more coastal conditions) may be important for the long-term survival and conservation of C. r. var. robusta. Lands designated as critical habitat are under private, city, and State jurisdiction. The approximate areas of designated critical habitat by land ownership are shown in Table 1.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chorizanthe robusta var. robusta critical habitat consists of four components (67 FR 36822-36845):

(i) Sandy soils associated with active coastal dunes, coastal bluffs with a deposition of windblown sand, inland sites with sandy soils, and interior floodplain dunes;

(ii) Plant communities that support associated species, including coastal dune, coastal scrub, grassland, maritime chaparral, oak woodland, and interior floodplain dune communities, and have a structure such that there are openings between the dominant elements (e.g, scrub, shrub, oak trees, clumps of herbaceous vegetation);

(iii) Plant communities that contain no or little cover by nonnative species which would complete for resources available for growth and reproduction of Chorizanthe robusta var. robusta; and

(iv) Physical processes, such as occasional soil disturbance, that support natural dune dynamics along coastal areas.

**Special Management Considerations or Protections**

Special management considerations or protections may be needed to maintain the primary constituent elements for Chorizanthe robusta var. robusta within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of C. r. var. robusta are maintained, and have the ability to reproduce and disperse into surrounding habitat at those sites. In other cases, however, active management may be needed to maintain the primary constituent elements for C. r. var. robusta. We have outlined below the most likely kinds of special management and protection that C. r. var. robusta may require. (1) In near-coastal areas, the supply and movement of sand along the coast must be maintained to create the dynamic dune habitats that are needed for

Chorizanthe robusta var. robusta. (2) In more interior locations, the sandy soils on which Chorizanthe robusta var. robusta is found should be maintained to optimize conditions for the species. Physical properties of the soil, such as its chemical composition, salinity, and drainage capabilities would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and dispersal agents are maintained. The use of pesticides should be limited or restricted so that viable populations of pollinators are present to facilitate reproduction of Chorizanthe robusta var. robusta. Fragmentation of habitat through construction of roads and certain types of fencing should be limited so that seed dispersal agents may move seed of C. r. var. robusta throughout the unit. (4) In some plant communities, it may be important to maintain a mosaic of different-aged stands of coastal scrub or maritime chaparral patches so that openings that support Chorizanthe robusta var. robusta will be maintained. Depending on location, the use of prescribed fire, thinning, or other forms of vegetation management may be useful in creating and maintaining this type of mosaic. (5) In all plant communities where Chorizanthe robusta var. robusta occurs, invasive, non-native species such as harding grass (Phalaris aquaticus), veldt grass (Ehrharta spp.), European beachgrass, iceplant, and other species need to be actively managed to maintain the open habitat that C. r. var. robusta needs. (6) Certain areas where Chorizanthe robusta var. robusta occurs may need to be fenced to protect them from accidental or intentional trampling by humans and livestock. While C. r. var. robusta appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect C. r. var. robusta during its critical season of growth and reproduction.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (self-fertilization) (USFWS, 2010)

**Lifespan**

Adult: 1 year (annual) (USFWS, 2010)

**Breeding Season**

Adult: April to June (USFWS, 2010)

**Key Resources Needed for Breeding**

Adult: Murphy (2003) revealed that insect pollination significantly increased seed set for C. robusta var. robusta, suggesting that pollinators may enhance its overall fitness. (USFWS, 2010)

**Reproduction Narrative**

Adult: Chorizanthe robusta var. robusta is a short-lived annual spineflower in the Pungentes section of the genus Chorizanthe, in the buckwheat family (Polygonaceae). Chorizanthe robusta var. robusta is self-compatible and capable of self-fertilization, seed set was demonstrated to be higher in individuals that were insect pollinated. Germination of Chorizanthe robusta var. robusta occurs during winter months; flowering occurs from April through June, and in some cases throughout the summer. (USFWS, 2010)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Sand/dunes (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Requires open canopy; shade intolerant (USFWS, 2010)

**Environmental Specificity**

Adult: Narrow/specialist

**Site Fidelity**

Adult: Moderate (inferred from USFWS, 2010)

**Habitat Narrative**

Adult: Specific biological and physical habitat components that are essential to the conservation of Chorizanthe robusta var. robusta include sandy soils associated with active coastal dunes and inland sites with sandy soils; plant communities that support associated species, including coastal dune, coastal scrub, grassland maritime chaparral, and oak woodland communities, and have a structure such that there are openings between the dominant elements; plant communities that contain little or no cover by nonnative species that would compete for resources available for growth and reproduction of C. robusta var. robusta; and physical processes, such as occasional soil disturbance, that support natural dune dynamics along coastal areas (Service 2004). (USFWS, 2010)

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (inferred from USFWS, 2010)

**Dispersal**

Adult: High (inferred from USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: Seeds disperse when the involucral spines attach to passing animals. Small mammals and birds are the most likely seed dispersers of Chorizanthe robusta var. robusta; though wind also plays a part in the dispersal of seeds (Service 2004). (USFWS, 2010)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

11 Populations. 9 populations with plants (extant) (USFWS, 2023).

**Population Size:**

Total counts ~199,000 total plants (9 populations) (USFWS, 2023).

**Population Narrative:**

Currently, there are 11 populations in Santa Cruz County over a range of approximately 21 miles (33.8 km). Three sites are on park lands that support large populations on the order of 10,000 individuals or more; the other seven sites support significantly smaller populations (USFWS 2004). Population size value left blank for this seed-banking annual because the large number of individuals suggests a sense of security that is not warranted. Approximately 12 occurrences observed since 1989 (CNDDB 2008). Known from 10 sites that support a total of 12 populations (USFWS 2004). Recent management actions performed by Baron and Eidam at the Pogonip sites may prove that slight disturbance can be beneficial for populations of C. robusta var. robusta. The disturbance can create necessary open areas that increase light, heat, and water, and may improve conditions for ground nesting pollinators (Murphy 2003). While we believe stochastic extinction is less of a threat now for C. robusta var. robusta than at the time of listing, it is still a concern for several of the smaller-sized populations. (USFWS, 2010) . 11 Populations. 9 populations with plants (extant). Total counts ~199,000 total plants (9 populations (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Recreation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the various park units at Pogonip and Sunset and Manresa State Beaches, recreational activities can have an impact on Chorizanthe robusta var. robusta, although low to moderate levels of impacts may be beneficial. Recent management actions performed by Baron and Eidam at the Pogonip sites may prove that slight disturbance (in this case, scraping with a McLeod) can be beneficial for populations of C. robusta var. robusta. The disturbance can create necessary open areas that increase light, heat, and water, and may improve conditions for ground nesting pollinators (at Pogonip, Steniolia elegans (digger wasp) and an undescribed wasp species of the genus Tachysphex (Murphy 2003)). These populations at Pogonip showed a large increase in numbers after management actions were implemented (Baron and Eidam 2008). Conversely, without proper management, high levels of recreational impact at these park sites (i.e., horseback riding and mountain biking) may eliminate the taxon altogether (Service 2004). (USFWS, 2010)

**Stressor:** Invasive plants (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An observation in 2009 reported that the Branciforte population appears healthy; however, the presence of a chain link fence for excluding off-highway vehicles is barring fire safety mowing that had previously helped control invasive trees from encroaching into the population. As a result, the population is now also being threatened by invasives, particularly Ailanthus altissima (tree of heaven) (Cheap, in litt. 2009a). Upon further observation at the Branciforte site, it is clear that Chorizanthe robusta var. robusta is well established there and has the potential to flourish. However, Ailanthus altissima is prolific and abundant within the C.

robusta var. robusta population and is an even more imminent threat than originally considered (Chang and Glenn, Service biologists, pers. obs. 2009b). The shade created by this non-native tree will inevitably eliminate C. robusta var. robusta from the site. In addition to Ailanthus altissima, other species that have been identified as threats to the Branciforte population are Rubis ursinus (Pacific blackberry), Rubis discolor (Himalayan blackberry), Carpobrotus edulis (iceplant), Lathyrus latifolius (sweet pea), Genista monspessulana (French broom), Lobularia maritima (sweet alyssum), and Lotus scoparius var. scoparius (deerweed) (Boursier and Hardwicke 2007). (USFWS, 2010)

**Stressor:** Residential development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Populations of Chorizanthe robusta var. robusta on private lands are subject to additional and sometimes more serious threats. The Branciforte site has been approved by the City of Santa Cruz for a housing development project, though it is unknown when construction activities will begin. The Service and the California Native Plant Society (CNPS) submitted comments recommending larger buffer areas for C. robusta var. robusta populations. In the early 1990s, the Freedom population at Aptos High School suffered losses of Chorizanthe robusta var. robusta individuals when land was modified in preparation for lot divisions. Additionally, in the late 1990s, the school widened a foot path running through the population in order to accommodate vehicles (Service 2004). An observation made in 2004 recorded in the CNDDB reported that a large colony east of the school baseball field remained intact, but that plants below the parking lot were eliminated by construction. Upon subsequent observation at this site, C. robusta var. robusta was visible along a foot trail southeast of the baseball field, growing on the edges of the trail, where the sandy soil is loose and there is less growth of other plants (Chang and Glenn, pers. obs. 2009a). (USFWS, 2010)

**Stressor:** Herbivory (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Baron and Bros (2005) investigation of insect herbivory on Chorizanthe robusta var. robusta concluded that insect herbivores reduced plant size, significantly decreasing both size and lifetime seed production of C. robusta var. robusta, subsequently compromising the plant's ability to obtain resources. In addition, rabbits browsing on C. robusta var. robusta removed mature seed heads from 11 percent of the study plants. The results of this study suggest that effects of herbivory can potentially be a threat to C. robusta var. robusta, or exacerbate other threats to C. robusta var. robusta populations (Baron and Bros 2005). (USFWS, 2010)

**Stressor:** Variation in annual weather patterns (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Annuals and other monocarpic plants (individuals that die after flowering and fruiting), such as Chorizanthe robusta var. robusta, are typically vulnerable to random fluctuations or variation in annual weather patterns and other environmental factors (Service 1994). (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. (USFWS, 2010)

**Stressor:** Stochastic extinction (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A small population size may make it difficult for a species to persist while sustaining other impacts such as habitat alteration that favors non-native species. Although Chorizanthe robusta var. robusta is self-compatible and capable of self-fertilization, seed set was demonstrated to be higher in individuals that were insect pollinated. Small populations may also have a more difficult time attracting pollinators and therefore may experience lower seed viability rates. Many of the populations appear to be stable or support a larger number of individuals than we knew of at the time of listing. While we believe stochastic extinction is less of a threat now for C. robusta var. robusta than at the time of listing, it is still a concern for several of the smaller-sized populations. (USFWS, 2010)

**Stressor:** Competition (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from nonnative species, or native shrub and tree species, can lead to declines in population abundance from shading and competition for resources (Service 2004, pp. 22-23; Service 2010, pp. 10, 12). The Freedom population, as well as the Ellicott Slough population, are believed to have declined to zero at least in part from shrub and tree shading as well as invasion by nonnative annual grasses (Service 2010, pp. 10, 12). Management actions to reduce competing vegetation and reduce canopy shading at the Branciforte and both Pogonip populations have resulted in increasing abundance of robust spineflower at those locations, suggesting that competition remains a threat to the species, but is a threat that can be successfully mitigated with management. The coastal populations at Manresa and Sunset State Beaches are likely persisting in the absence of management due to natural habitat conditions that inhibit establishment of shrub, trees, and nonnative annual species through moderate levels of disturbance. In the absence of natural disturbance processes, or management to reduce competing biomass, competition will remain a threat to robust spineflower (USFWS, 2023).

**Stressor:** Herbivory (USFWS, 2023)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Moth larvae and brush rabbits have been observed to decrease plant size and reduce seed output of robust spineflower, but herbivory has not been attributed to the declines observed at the Ellicott Slough and Freedom populations (Baron and Bros 2005). Herbivory is most likely not a severe threat to robust spineflower but is a contributing factor that may be inhibiting recovery or exacerbating the effects of other threats (USFWS, 2023).

**Stressor:** Vandalism (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There have been four documented instances of vandalism at three different occurrences of robust spineflower since 2019. A trailer was moved onto the Merk Road occurrence and abandoned in 2019 (Olberding 2019, pp. 20-21). This resulted in a broken fence and rutting, although the population appeared to rebound without management upon the removal of the trailer (Olberding 2021b, p. 13). In both 2019 and 2021, a homeless encampment was established at the Pogonip 1 occurrence which resulted in trampling and trash accumulation. Remediation in both years involved removing debris and the population appeared to rebound without additional management (K. Lyons pers. com. 2022). At the Branciforte population, a firebreak was established outside of the timeframe established in the Mitigation and Monitoring Plan (Olberding 2021a, pp. 20-21, 24; Olberding 2021b pp. 21, 24-25). The effect to the population is likely low since the disturbance was confined to the margin of the preserve area used as a buffer zone. Enforcement of the timing of establishing fire breaks has proven difficult because the action is being undertaken by an unknown entity. The prohibited actions are not believed to have resulted in a significant decline of individuals due to the estimated abundance observed during annual monitoring relative to the comparatively small loss of individuals. However, the repeated nature of the events shows that enforcement has been unsuccessful and future, more destructive vandalism is possible at this location. Each of these vandalism events were not purposeful actions to remove robust spineflower. The Pogonip occurrence appears to have a location that is attractive to the establishment of homeless encampments, and this may continue to occur as this societal problem persists. The Merk Road location is along a road lending itself towards vehicle or other refuse abandonment. The vandalism at the Branciforte occurrence was conducted for perceived safety reasons and not to intentionally remove robust spineflower. Fortunately, none of these actions have been observed to have resulted in sustained declines of individuals and monitoring at all locations is planned for future years (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**

1. Within each recovery unit, the number of populations and acreage of occupied habitat for each population has been protected. (USFWS, 2004)

2. Habitat in each protected population has been appropriately managed and restored. (USFWS, 2004)

3. Population monitoring shows a stable or increasing trend in population size or density during favorable precipitation years over at least 10 years. (USFWS, 2004)

Recovery Priority Number: 9

**Delisting Criteria:**
1. Within each recovery unit, the number of populations and acreage of occupied habitat for each population has been protected. (USFWS, 2004)

2. Habitat in each protected population has been appropriately managed and restored. (USFWS, 2004)

3. Population monitoring shows a stable or increasing trend in population size or density during favorable precipitation years over at least 10 years. (USFWS, 2004)

4. The total number of populations has increased to at least 18, at least 15 of which have an average population of 1,000 individuals in favorable (nondrought) rainfall years over at least 10 years (beyond the downlisting monitoring period). (USFWS, 2004)

**Recovery Actions:**
- Protect habitat for Chorizanthe robusta var. robusta at all existing sites. (USFWS, 2004)
- Manage habitat for Chorizanthe robusta var. robusta at existing sites. (USFWS, 2004)
- Conduct management-oriented research. (USFWS, 2004)
- Establish populations in appropriate habitat within the historical range of the species. (USFWS, 2004)
- Review and revise recovery criteria as new information becomes available. (USFWS, 2004)
- Develop and implement an outreach program. (USFWS, 2004)
- 1. Establish and/or continue long-term management and monitoring programs for Chorizanthe robusta var. robusta populations, particularly those on park and refuge lands. (USFWS, 2010)
- 2. Continue genetic research to clarify uncertainties within the Chorizanthe robusta/Chorizanthe pungens complex. (USFWS, 2010)
- 3. Investigate opportunities for conservation of the Branciforte population, and remove Ailanthus altissima (tree of heaven) and other invasive species at the site, in accordance with the “Branciforte Creek Residential Development Robust Spineflower (Chorizanthe robusta var. robusta) Management and Monitoring Plan,” whether or not planned development goes forth. (USFWS, 2010)
- 4. Conduct surveys on suitable habitat and within the historical range to locate new populations, in conjunction with examination of genetic information to ensure the plant’s identity. Discovery of additional new populations such as the population at Merk Road will broaden our understanding of Chorizanthe robusta var. robusta’s status, its habitat, and range. (USFWS, 2010)
- 5. Initiate an outplanting program to establish new Chorizanthe robusta var. robusta populations in appropriate habitat within its historical range by: a. locating appropriate habitat for outplanting; b. conducting experimental habitat enhancement; c. applying appropriate habitat enhancement techniques; d. conducting propagation experiments to determine the best techniques for developing material to use in introductions; e. conducting experimental introductions; f. developing a protocol to guide introductions; g. conducting large-scale introductions on appropriate sites; and h. monitoring newly established populations (Service 2004). (USFWS, 2010)

- 6. Establish an outreach program to increase public awareness for populations on both public and private lands, particularly on park lands, refuges, and at Aptos High School. (USFWS, 2010)
- 7. Revise the recovery plan and recovery criteria as appropriate based on new information and/or research. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. All occurrences should be revisited to evaluate presence and suitable habitat. 2. Occurrences currently protected from development should be managed to reduce competing vegetation using the Pogonip occurrences or Branciforte as an example of successful methodologies. 3. Reintroductions within the current and historical range should be considered to evaluate techniques for population establishment and specific ecological site conditions (USFWS, 2023).

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# SPECIES ACCOUNT: *Chorizanthe valida* (Sonoma spineflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 06/22/1992; California/Nevada (Region 8)

**Physical Description**

A herbaceous annual, very similar in appearance to Chorizanthe howellii (Howell's spineflower), the primary distinguishing characteristic of C. valda being its ascending to erect growth habit and the brightly colored red and white involucres. The bright red base of the involucre's straight spines contrasts with their bright ivory tips, and the red spine bases contrast sharply with the dull-colored involucral tube. The basal leaves of C. valida are 1 to 2.5 centimeters (0.4 to 0.9 inch) long, 4 to 8 millimeters (0.2 to o.3 inch) wide, and often less hairy on the top surface than underneath. The flowers are 5 to 6 millimeters (0.2 to 0.3 inch) long. (USFWS, 1998)

**Taxonomy**

Closely related to C. pungens (Bittman 1998). (NatureServe, 2015) The Sonoma spineflower, Chorizanthe valida, was described by Sereno Watson in 1877 from specimens collected in 1840-41 by Ilya G. Vosnesensky, an entomologist and curator ofthe Zoological Museum in St. Petersburg, Russia, who traveled and collected in northern California. (USFWS, 1998)

**Historical Range**

The Point Reyes area in Marin County, California. Possible historical occurrences from the interial portion of Sonoma County. (USFWS, 2010)

**Current Range**

Near the eastern end of Abbott's Lagoon on the Lunny "G" Ranch, at Point Reyes National Seashore (PRNS) in Marin County, California. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 1998)

**Breeding Season**

Adult: June to August (USFWS, 1998)

**Reproduction Narrative**

Adult: Chorizanthe valida is an herbaceous annual in the buckwheat family (Polygonaceae). Flowers, which appear June through August, are white to lavender to rose in color, are 5 to 6 mm (0.20 to 0.24 in long (Reveal and Hardham 1989) and occur in dense, ball-shaped, pinkish clusters with green bracts below. (USFWS, 1998; USFWS, 2010)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland/herbaceous (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Mild maritime climate, characterized by fog and winter rains (USFWS, 1998)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 2010)

**Habitat Narrative**

Adult: The Abbott's Lagoon colony is located in coastal prairie grassland and occurs on the Sidrak sand soil type, consisting of well-drained, Pleistocene dune sands with a 2-4 percent slope, bearing to the north-northwest (towards Abbott's Lagoon). This soil type has low to moderate available water capacity, and can support only a limited plant community that is drought tolerant (Davis and Sherman 1992). The species occurs in areas of relatively mild maritime climate, characterized by fog and winter rains. The fog helps keep summer temperatures cool and winter temperatures relatively warm, and provides moisture in addition to the normal winter rains. (USFWS, 1998; USFWS, 2010)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (USFWS, 1998)

**Dispersal**

Adult: Low (USFWS, 1998)

**Dispersal/Migration Narrative**

Adult: After about a month, the dull brown flowerhead begins to disintegrate and the spiny seeds are dispersed on the ground nearby. (USFWS, 1998)

***Population Information and Trends***

**Population Trends:**

Variable (USFWS, 2010)

**Number of Populations:**

1 (USFWS, 2024)

**Population Size:**

low of 62,580 individuals in 2006 and a high of 958,380 individuals in 2010 (USFWS, 2024).

**Additional Population-level Information:**

Following rediscovery and prior to listing, abundance information was collected by the Marin Chapter of the California Native Plant Society. Between 1983–1986, the area occupied by the species fluctuated between 100 square meters and 17,000 square meters (Service 1998, p. 26). Since listing, the estimated area covered by the species and estimated number of individuals has continued to fluctuate. Refer to Table 1 below for all abundance information for the natural occurrence following the species rediscovery. Data gathered from 2002 to 2004 have been rejected due to statistical invalidity; following 2004, updated survey methods were enacted to assess the population size more accurately and rapidly (Service 2010, p. 5). With that, from 2005–2023, the average abundance of the natural Sonoma spineflower population was 208,648 individuals, with a low of 62,580 individuals in 2006 and a high of 958,380 individuals in 2010 (USFWS, 2024).

**Population Narrative:**

A single extant endemic population of Chorizanthe valida exists near the eastern end of Abbott's Lagoon on the Lunny "G" Ranch, at Point Reyes National Seashore (PRNS) in Marin County, California at an elevation of approximately 15 meters (49 feet) above sea level. The population of Chorizanthe valida at Abbott's Lagoon exists as two disjunct subpopulations that are spatially separated from each other by approximately 80 meters (262 feet). The larger of the two subpopulations is referred to as the "main population" and is approximately 4 times as large as the smaller of the two subpopulations. The smaller of the two subpopulations is referred to as the "sub-population". Based on the results of mapping the spacial distribution of the population in 1999, 2000, 2005, 2006 and 2008, the area occupied by Chorizanthe valida at Abbott's Lagoon fluctuates seasonally, but does not appear to be contracting (Williams 2008). According to the recovery plan (Service 1998), the entire Abbott's Lagoon population of C. valida was estimated to cover 358 square meters (1,076 square feet) in 1983. In 1984, more than 2,000 plants covered an area of 5,130 square meters (16,829 square feet) (Fowler and Fellers 1984). According to Davis and Sherman (1992), the entire population exists within 17,000 square meters (55,773 square feet). Between 1983 and 1998, the California Native Plant Society (CNPS) conducted a census of the population and the number of individuals varied widely from 100 to 30,000 plants (Rogers 2005). In 1999, PRNS staff began developing a long-term, quantitative monitoring program for the Abbott's Lagoon population. Over the next 6 years, several monitoring methods were tested. In 1999, the number of Chorizanthe valida plants in the main population was estimated to be 18,000. In 2001, the number was calculated to be 184,311 individuals. The main population was not counted in 2000 or after 2002. From 2002 to 2004 permanent monitoring plots were used as indicators of the overall population trend in the main population. However, data collected using these permanent plots have now been rejected due to statistical invalidity. The number of plants in the sub-population has increased dramatically each year it has been censused, from 4,707 individuals in 1999 to 16,836 in 2001. Beginning in 2005, PRNS staff began sampling the main population of Chorizanthe valida using a macroplot. The macroplot is 100 x 40 meters (328 x 131 feet), encompassing 35 temporary quadrats each measuring 40 x 0.05 meters (131 x 0.16 feet). Sample results estimated there were 560,171 plants in the macroplot in 2005, with 95% confidence that the true number of plants in the macroplot is between 470,000 and 650,275. Data extrapolation to the entire population is beyond reasonable statistical inference. Since 2005, the population within the macroplot has fluctuated from an estimated 62,580 individuals in 2006 to 710,460 individuals in 2009. (USFWS, 2010)

***Threats and Stressors***

**Stressor:** Recreation (USFWS, 2010)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Trampling by hikers and accidental incursion still pose a minor threat to C. valida. (USFWS, 2010)

**Stressor:** Off-road vehicles (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Due to the presence of a road that bisects the Abbott's Lagoon population, which is used for ranching activities, off-road vehicle use still poses a threat. However, off-road vehicle use within PRNS is not permitted for recreational purposes and the road bisecting the Abbott's Lagoon population is scheduled for realignment in 2010; thus, this threat will be drastically reduced as a result. (USFWS, 2010)

**Stressor:** Cattle grazing (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The unknown effects of cattle grazing also remain a threat. However, since Chorizanthe valida is unpalatable to cattle and cattle consume many of the nonnative invasive plants that threaten the species, the removal of cattle from the system could in itself threaten the species. Due to the results of Davis and Sherman (1992), it is now believed the damaged caused by livestock trampling is outweighed by the benefits of grazing livestock in reducing competition with other plant species. (USFWS, 2010)

**Stressor:** Stochasticity (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because Chorizanthe valida exists as a single endemic population and a single reintroduced population, with plant densities that fluctuate annually, it is highly susceptible to stochastic events such as prolonged drought, fire, disease, or other unforeseen causes of extinction. Stochasticity remains a major threat to the species. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and when climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. (USFWS, 2010)

**Stressor:** Nonnative invasive species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The population of Chorizanthe valida at Abbott's Lagoon is surrounded by the invasive perennial grass species Holcus lanatus (common velvetgrass) on all sides. This nonnative invasive grass is of concern to the long term management of this population. As part of the Preventing Extinction Grant awarded to PRNS, H. lanatus and Lupinus arboreus will be removed from the area. Regardless, nonnative invasive species remain an ongoing threat to C. valida. (USFWS, 2010)

**Stressor:** Fire suppression (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The effects of fire suppression on Chorizanthe valida are not known. The natural fire return interval at PRNS is likely relatively long due to persistently moist and cool conditions coupled with relatively low incidence of lightning strikes (Keeley 2002). However, the use of fire by Native Americans in the area is not known. (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
A/1: At least six successful populations have been established. These populations will be considered self-sustaining populations after 15 years, which includes a normal precipitation cycle. (USFWS, 2019)

A/2: The area of each Sonoma spineflower population is maintained at or above approximately 2 acres in size. (USFWS, 2019)

A/3: The cover of invasive native and non-native plants, such as bush lupine, at all sites is controlled at <1% within areas containing Sonoma spineflower. (USFWS, 2019)

A/4: There are management measures implemented to address the threats of invasive species and other problems, including pedestrians and off-road vehicles at some sites. (USFWS, 2019)

A/5: Monitoring reveals that management actions are successful in reducing threats of invasive non-native species. (USFWS, 2019)

E/1: The number of individuals within each Sonoma spineflower population remains at or above 90,0004 for 15 years, which includes cycles of normal precipitation. (USFWS, 2019)

E/2: Seeds are stored in at least two Center for Plant Conservation certified facilities; seed germination, propagation, and out-planting propagation techniques are understood. (USFWS, 2019)

Recovery Priority Number: 5

**Delisting Criteria:**
A/1: At least eight successful populations have been established on appropriate habitat [that] has been secured within the historic range. Populations will be self-sustaining after 15 years, which includes a normal precipitation cycle. (USFWS, 2019)

A/2: Further invasion or increase in non-native or native invasive plant species has been prevented, including perennial species such as bush lupine and coyotebrush, within all Sonoma spineflower populations. (USFWS, 2019)

A/3: Habitat occupied by the species that is needed to allow delisting has been voluntarily secured, with long-term commitments and, if possible, endowments to fund [the] conservation of the native vegetation. (USFWS, 2019)

E/1: Ensure that seed banking practices, including seed germination, propagation, and outplanting propagation techniques, are understood and implemented as needed. (USFWS, 2019)

E/2: Seeds at banking facilities are renewed at a rate to ensure that seed stores remain viable in perpetuity. (USFWS, 2019)

**Recovery Actions:**
- Protect habitat of the listed species and their occurrences on private lands. The listed species should be secured where they occur on private lands through conservation easements, conservation agreements, or purchase where there are willing sellers. This is necessary to prevent further declines in distribution and abundance of the listed species from loss and degradation of habitat. The development of cooperative weed control programs will greatly facilitate recovery of these species, so it is a high priority to develop landowner incentives and providing funds for control of invasive exotic vegetation is a high priority. This task regularly refers to “occurrences” as defined by the NDDB. Readers are reminded that “occurrences” are convenient units for storing data, and do not necessarily coincide with biological populations nor with geographic units of vegetation or geological features such as the dune fields upon which these plants depend. (USFWS, 1998)
- Minimize threats to the plants from invasive non-native species, and minimize threats on private and public lands. Invasive non-native plant species are immediate biological threats the listed plant species. Infestations of invasive plant species need to be controlled. (USFWS, 1998)
- Develop management strategies through a research program to document the listed species’ life histories and their responses to vegetation management. Habitat management for the species in this recovery plan is needed to control the threats to their existence. Data must be obtained to determine how to conduct the management. (USFWS, 1998)
- Manage occurrences and habitats. Management of the listed plant species and its habitat will depend upon information gained from monitoring, threat analysis and the evaluation of protection alternatives. It will be important to involve the expertise of local landowners, land managers, and species experts to develop conservation programs. There may be different management programs for each species. The management program selected will require periodic review to ensure that it is effective in protecting the species. (USFWS, 1998)
- Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria. (USFWS, 1998)

- Coordinate recovery actions to protect other listed species and species of special concern. Other rare and endangered wildlife species occur within the ranges of the listed plant species. Management actions, such as the removal of invasive non-native plant species through herbicide application, may affect these species. Management actions should avoid adverse impacts to these species and their habitats, and actively include them in recovery actions to facilitate their reoccupation of historic ranges and prevent range collapse or declines in their abundance. (USFWS, 1998)
- Develop ecosystem restoration and multi-species reintroduction projects at degraded dune systems. Numerous dune systems within the historic range of listed species and species of concern have either reduced value or none for them because of past or ongoing degradation of habitat quality. Benefits for multiple species can be efficiently regained by establishing habitat and population restoration programs for these undermanaged or degraded dune systems. By returning independent dune systems within historic range of rare species to current ecological function, the risk of species extinction can be substantially decreased. (USFWS, 1998)
- Develop and implement an outreach program. Increasing public awareness of the listed plant species will facilitate efforts to preserve the species,, associated rare species, and the coastal dune ecosystem. Prepare and distribute regionally specific informational brochures and audio-visual and sign programs on preservation and recovery. Through the cooperative interagency working groups, prepare brochures and audio-visual materials that describe the plight of the listed species and the regional efforts being undertaken for their recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities, such as park interpretive programs and school programs. Prepare interpretive educational signs for PRNS and other locations. (USFWS, 1998)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 1. Establish or protect additional populations of Sonoma spineflower. 1.1 Introduce at least three new self-sustaining populations (Priority 1) 1.2 Research possible insect pollinator species to determine appropriate management strategies for reintroduction sites. 1.3 Continue work on seedbank dynamics with the goal of using the information to run a population viability analysis on the species (Priority 2). 1.4 Research to determine what might cause population declines within the wild population, focusing on grazing intensity and pollinators (Priority 1) (USFWS, 2019)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 2. Conduct research to better understand life history and annual establishment. 2.1 Determining the extent of Sirdrak Sand outside of the park to help inform the location of potential introduction sites (Priority 3). 2.2 Conduct an analysis of soil type and nutrients/water balance, vegetation cover, disturbance dynamics (grazing, rodents, rabbits) to identify new introduction sites outside of the PRNS to determine if appropriate habitat exists for possible reintroductions (Priority 3). 2.3 Research the potential to augment nesting habitat for main pollinators near some of the current and future introduction sites (Priority 3). (USFWS, 2019)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 3. Monitor and manage existing populations on protected lands. 3.1 Maintain shrub cover within existing sites at acceptable levels through removal, as necessary (Priority 3). 3.2 Determine where some of the main pollinators identified in the two years of study on Sonoma spineflower nest near these populations (Priority 3). 3.3 Research the potential to augment

nesting habitat for main pollinators near some of the current and future introduction sites (Priority 3). (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several conservation and monitoring recommendations, which we believe will aid in the recovery of the Sonoma spineflower. Some of these recommendations have already been discussed in the 2010 5-Year Review and 2019 Recovery Plan Amendment (Service 2010, p. 15; Service 2019, pp. 8–9) and remain valid. 1. Continue annual surveys at all occupied sites. 2. Finalize the species' management plan for the Point Reyes National Seashore. 3. Manage competing vegetation: a. Remove/reduce yellow bush lupine and coyote brush in all occupied areas to prevent continued habitat degradation. b. Remove thatch and competing vegetation annually. c. Consider the removal of other invasive species outside of occupied areas, which may be influencing cattle to graze more frequently in Sonoma spineflower habitat. 4. Research to determine what might cause population declines within the wild population, focusing on grazing intensity and pollinators. 5. Investigate the feasibility of augmenting nesting habitat for main pollinators near some of the current and future introduction sites. 6. Consider re-seeding previously seeded areas that were unsuccessful or are self-sustaining in low numbers. 7. Identify and consider permanently protecting locations within the Sonoma spineflower's historical range that contain suitable habitats for future outplantings. 8. Attempt outplanting at new locations on protected private and public land within the Sonoma spineflower's historical range (USFWS, 2024)

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# SPECIES ACCOUNT: *Chromolaena frustrata* (Cape Sable Thoroughwort)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Chromolaena frustrata is a perennial herbaceous plant. Mature plants are 5.9 to 9.8 inches (in) (15 to 25 centimeters (cm)) tall with erect stems. The blue to lavender flowers are borne in heads, usually in clusters of two to six. Flowers are produced mostly in the fall, though sometimes year round. (USFWS, 2014)

**Taxonomy**

Chromolaena frustrata (Family: Asteraceae)was first reported by Chapman, from the Florida Keys in 1886, naming it Eupatorium heteroclinium (Chapman 1889). Synonyms include Eupatorium frustratum B.L. Robinson and Osmia frustrata (B.L. Robinson) Small. (USFWS, 2014)

**Historical Range**

Chromolaena frustrata was historically known from Monroe County, both on the Florida mainland and the Florida Keys, and in Miami-Dade County along Florida Bay. The species was observed historically on Big Pine Key, Boca Grande Key, Fiesta Key, Key Largo, Key West, Knight's Key, Lignumvitae Key, Long Key, Upper Matecumbe Key, and Lower Matecumbe Key. (USFWS, 2013)

**Current Range**

In Everglades National Park, 11 Chromolaena frustrata populations supporting approximately 1,600 to 2,600 plants occur in buttonwood forests and coastal hardwood hammocks from the Coastal Prairie Trail near the southern tip of Cape Sable to Madeira Bay. In the Florida Keys, Chromolaena frustrata is now only known from Upper Matecumbe Key, Lower Matecumbe Key, Lignumvitae Key, Long Key, Big Munson Island, and Boca Grande Key (USFWS, 2013)

**Critical Habitat Designated**

Yes; 2/7/2014.

**Legal Description**

On January 8, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 7, 2014) for Chromolaena frustrata (Cape Sable Thoroughwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Florida (79 FR 1552-1590).

**Critical Habitat Designation**

The critical habitat designation for Chromolaena frustrata includes nine CHUs in Sabine and San Augustine Counties, Texas. This species critical habitat encompasses approximately 10,968 acres (ac) (4.439 hectares (ha)). General descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (79 FR 1552-1590).

Unit 1: Everglades National Park, Monroe County and Miami-Dade County: Unit 1 consists of a total of 6,166 acres (2,495 hectares) in Monroe and Miami-Dade Counties. This unit is composed entirely of lands in Federal ownership, 100 percent of which are located within the Everglades National Park.

Unit 2: Key Largo, Monroe County: Unit 2 consists of a total of 3,431 acres (1,388 hectares) in Monroe County. This unit is composed of Federal lands within Crocodile Lake National Wildlife Refuge (NWR) (804 acres (325 hectares)); State lands within Dagny Johnson Botanical State Park, John Pennekamp Coral Reef State Park, and the Florida Keys Wildlife and Environmental Area (2,170 acres (878 hectares)); and parcels in private ownership (457 acres (185 hectares)).

Unit 3: Upper Matecumbe Key, Monroe County, Florida: Unit 3 consists of 69 acres (28 hectares) in Monroe County. This unit is comprised of State lands within Lignumvitae Key State Botanical Park, Indian Key Historical State Park (24 acres (10 hectares)); City of Islamorada lands within the Key Tree Cactus Preserve and Green Turtle Hammock Park and parcels in private ownership (45 acres (18 hectares)).

Unit 4: Lignumvitae Key, Monroe County: Unit 4 consists of a total of 180 acres (73 hectares) in Monroe County. This unit is composed entirely of lands in State ownership, 100 percent of which are located within the Lignumvitae Key Botanical State Park on Lignumvitae Key in the Florida Keys. This unit includes the entire upland area of Lignumvitae Key.

Unit 5: Lower Matecumbe Key, Monroe County: Unit 5 consists of a total of 44 acres (18 hectares) in Monroe County. The unit is composed of State lands within Lignumvitae Key Botanical State Park and parcels owned by the Florida Department of Transportation (22 acres (9 hectares)), and parcels in private ownership (22 acres (9 hectares)).

Unit 6: Long Key, Monroe County: Unit 6 consists of a total of 208 acres (84 hectares) in Monroe County. This unit is composed of State lands within Long Key State Park (151 acres (61 hectares)) and parcels in private ownership (57 acres (23 hectares)).

Unit 7: Big Pine Key, Monroe County: Unit 7 consists of a total of 780 acres (316 hectares) in Monroe County. This unit is composed of Federal land within the National Key Deer Refuge (686 acres (278 hectares)) and parcels in private ownership (94 acres (38 hectares)).

Unit 8: Big Munson Island, Monroe County Unit 8 consists of a total of 28 acres (11 hectares) in Monroe County. This unit is composed entirely of lands in private ownership.

Unit 9: Boca Grande Key, Monroe County: Unit 9 consists of a total of 62 acres (25 hectares) in Monroe County. This unit is composed entirely of lands in Federal ownership, 100 percent of which is located within the Key West National Wildlife Refuge.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chromolaena frustrata critical habitat consists of four components (79 FR 1552-1590):

(i) Areas of upland habitats consisting of coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse, calcareous, storm-deposited sediment. (B) Coastal rock barren (Keys cactus barren, Keys tidal rock barren) habitat that contains: (1) Open to semi-open canopy and understory; and (2) Limestone rock substrate. (C) Coastal hardwood hammock habitat occurring in Everglades National Park that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate of marl covered with a thin layer of highly organic soil. (D) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil, marl, humus, or leaf litter on top of the underlying limestone. (E) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) Plant communities of predominately native vegetation with either no invasive, nonnative species or with low enough quantities of nonnative, invasive plant species to have minimal effect on the survival of Chromolaena frustrata.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient area to sustain viable populations in coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Special management considerations or protection are necessary throughout the critical habitat areas to avoid further degradation or destruction of the habitat that contains those features essential for the conservation of the species. The primary threats to the physical or biological features that Chromolaena frustrata depends on include: (1) Habitat destruction and modification by development; (2) competition with nonnative, invasive plant species that changes the habitat composition and structure; (3) wildfire that destroys habitat; (4) hurricanes and storm surge, if too frequent or severe destroy or modify habitat making it unsuitable; and (5) sea-level rise that changes the habitat to a more saline environment. Some of these threats can be addressed by special management considerations or protection while others (e.g., sea-level rise, hurricanes) are beyond the control of landowners and managers. However, while landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats to the habitats. Management activities that could ameliorate these threats include the monitoring and minimizing recreational activities impacts, nonnative species control, and protection from development. Precautions are needed to avoid the inadvertent trampling of Chromolaena frustrata in the course of management activities and public use. Development of recreation facilities or programs should avoid impacting these habitats directly or indirectly. Ditching and filling should be avoided because they alter the hydrology and species composition of these habitats. Sites that have shown increasing encroachment of woody species over time may require efforts to maintain the open nature of the habitat, which favors these species. Nonnative species control programs are needed to reduce competition and prevent habitat degradation. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this rule. All critical habitat requires active management to address the ongoing threats listed. In summary, we find that each of the areas we are designating as critical habitat contain features essential to the conservation of Chromolaena frustrata that may require special management considerations or protection to ensure conservation of the species. These special management considerations and protections are required to preserve and maintain the essential features provided to C. frustrata by the ecosystems upon which it depends. A more detailed discussion of these threats is presented in the proposed rule under ‘‘Summary of Factors Affecting the Species’’ (77 FR 61836; October 11, 2012).

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2014)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2014)

**Reproduction Narrative**

Adult: The reproductive biology and genetics of Chromolaena frustrata have received little study. Fresh C. frustrata seeds show a germination rate of 65 percent, but germination rates decrease to 27 percent after the seeds are subjected to freezing, suggesting that long-term seed storage may present difficulties (Kennedy et al. 2012, pp. 40, 50–51). While there have been no studies on the reproductive biology of C. frustrata, the Service can draw some generalizations from other species of Chromolaena, which reproduce sexually. New plants originate from seeds. Pollinators are likely to be generalists, such as butterflies, bees, flies, and beetles (USFWS, 2014).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Barrens, forest, dune (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Moderate to full sun exposure (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits coastal rock barrens and berms, and sunny deges of rockland hammocks. The environmental specificity is narrow, as the plants occur only along the shore zone of limestone outcrops in southern Florida (NatureServe, 2015). Grows in open canopy habitats in coastal berms and coastal rock barrens and in semi-open to closed canopy habitats, including buttonwood forests, coastal hardwood hammocks and rockland hammocks (USFWS, 2014). It prefers moderate to full sun exposure (USFWS, 2013).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal is largely by wind (Lakshmi et al. 2011, p. 1) (USFWS, 2014).

***Population Information and Trends***

**Population Trends:**

Decline of 70-90% (NatureServe, 2015)

**Species Trends:**

30 - 50% decline (NatureServe, 2015)

**Number of Populations:**

8 (USFWS, 2013)

**Population Size:**

~5,000 (NatureServe, 2015)

**Adaptability:**

Moderate (inferred from USFWS, 2014)

**Population Narrative:**

Eupatorium frustratum's restricted ecological range, and its drastic loss of habitat suggest that the number of individuals is declining (Halupa 2002). It once ranged widely in the Florida Keys, and is now known there only from a few small sites; on the mainland, it had several historical localities, and is now known from just one site. This species has experienced a long-term decline of 70-90% and short-term decline of 30 - 50%. Thousands of plants occur densely in one area on Big Munson Island, making counting difficult; a few hundred plants altogether occur at the other sites. In total, fewer than 5,000 plants were estimated in 2003 (Bradley and Gann 2004) and the only population discovered since is not large (USFWS 2005). Only one population has good viability/integrity (NatureServe, 2015). The species appears to be able to rebound at affected sites within a few years (Bradley 2009, pers. comm.) (USFWS, 2014). The current range of Chromolaena frustrata includes eight populations spread across 209 km (130 mi) (USFWS, 2013).

***Threats and Stressors***

**Stressor:** Habitat modification and destruction (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat destruction and modification resulting from development are considered a major threat to Chromolaena frustrata throughout the species' range. The populations on Fiesta Key, Knights Key, Key Largo, and Key West were lost due to development. Fiesta Key is completely developed as a Kampgrounds of America (KOA) campground and is devoid of native plant communities. Knights Key is almost completely developed and has no remaining suitable habitat. Key Largo has undergone extensive disturbance and development. Two Chromolaena

frustrata populations, including the largest population (Big Munson Island), are located on private lands (the population at Long Key Layton Hammock only partially so), which are vulnerable to further development. (USFWS, 2013)

**Stressor:** Herbivory (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** On Big Munson Island, much of the Chromolaena frustrata population was observed to suffer from severe herbivory in 2004. No insects were observed on any plants, and the endangered Key deer (Odocoileus virginianus clavium) was the suspected culprit The significance of herbivory on C. frustrata population dynamics is unknown. (USFWS, 2013)

**Stressor:** Nonnative plant species (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Schinus terebinthifolius (Brazilian pepper), a nonnative, invasive tree, occurs in the habitat of this species. Schinus terebinthifolius forms dense thickets of tangled, woody stems that completely shade out and displace native vegetation. Schinus terebinthifolius can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for Chromolaena frustrata, which prefers moderate to full sun exposure. Colubrina asiatica (lather leaf), a nonnative shrub, has invaded large areas of coastal berm and coastal berm edges. Colubrina asiatica also forms dense thickets and mats, and is of particular concern in coastal hammocks. Casuarina equisetifolia (Australian pine) invades coastal berm and is a threat to suitable habitat at most sites that could support this species. Casuarina equisetifolia forms dense stands that exclude all other species through dense shade and a thick layer of needles that contain substances that leach out and suppress the growth of other plants. (USFWS, 2013)

**Stressor:** Small, isolated populations (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The current range of Chromolaena frustrata includes eight populations spread across 209 km (130 mi) between ENP and Boca Grande Key; four of eight C. frustrata populations consist of fewer than 100 individuals. These populations may not be viable in the long term due to their small number of individuals. Threats exacerbated by small population size include hurricanes, storm surges, climate change, freezing temperatures, and recreation impacts. (USFWS, 2013)

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Projections suggest that sea level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida (U.S. Climate Change Science Program (CCSP) 2008). This species occurs in habitats near sea level in areas of south Florida where considerable habitat is projected to be lost to sea level rise by the year 2100.

Most populations are located less than 2 m (6.6 ft.) above mean sea level, and the effects of sea level rise are expected to be a continual problem for these species and their habitats. Using Rahmstorf et al. (2007), sea level rise projections of 100 to 140 cm, 80.5 to 92.2 percent of the Florida Keys land area would be inundated by 2100. A 1.8-m (5.9-ft) rise would inundate all existing mainland Chromolaena frustrata occurrences in ENP (USFWS, 2013).

***Recovery***

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

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

**Recovery Actions:**

- Not available - this species does not have a recovery plan.
- Fairchild Tropical Botanic Garden (FTBG) has 44 seed collections of Chromolaena frustrata from ENP, which were provided to the National Center for Genetic Resources Preservation (NCGRP) for testing and storage, and one collection from Lignumvitae Key. Key West Botanical Garden (KWBG) has one collection of Chromolaena frustrata from Big Munson Island. Numerous C. frustrata are planted on the KWBG grounds (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support Chromolaena frustrata (USFWS, 2013).

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Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

# SPECIES ACCOUNT: *Cirsium fontinale var. obispoense* (Chorro Creek bog thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 1/17/1995; California/Nevada (Region 8)

**Physical Description**

A biennial or short-lived perennial plant up to 2 meters (m) (6.6 feet (ft)) tall in the aster and sunflower family (Asteraceae). The leaves are spiny with glandular hairs on the upper and lower surfaces. The flowers are white, pink, or lavender with a drooping posture (Figure 1). Each flower head produces an average of 73 seeds up that are up to 4 millimeters (mm) (0.2 inches (in)) long (Turner and Herr 1996). Seeds are topped with a pappus (set of bristles) that aids in dispersal. (USFWS, 2014)

**Taxonomy**

Chorro Creek bog thistle (Cirsiumfontinale var. obispoense) is in the composite family (Asteraceae) and is one of three varieties of C. fontinale and is distinguished from the other two by a combination of morphological characteristics involving the stem, leaf, inflorescence, flower, and fruit. Cirsium fontinale var. obispoense is geographically separated from the other two varieties. The species first was described by Edward L. Greene in 1886 as Cnicus fontinalis. Six years later, he transferredthe plant to the genus Carduus, and in 1901 Jepson transferred the plant to the genus Cirsium. In 1938, J.  (USFWS, 2014)

**Historical Range**

Local endemic on serpentine in San Luis Obispo County, California. (NatureServe, 2015)

**Current Range**

In San Luis Obispo County, California.  The known geographic range comprises 462 square km (178 square mi), extending from San Simeon Creek (35.630897°N, 121.060711°W) to the vicinity of the city of San Luis Obispo (a distance of 56 km (35 mi)). All known occurrences of Cirsium fontinale var. obispoense are west of the outer coast ranges of the Central Coast Region in San Luis Obispo County, California. (USFWS, 2014)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 2-3 years (USFWS, 2014)

**Breeding Season**

Adult: May to July and occasionally extends into September or October (Magney 2006). (USFWS, 2014)

**Reproduction Narrative**

Adult: Cirsium fontinale var. obispoense typically live 2 or 3 years. The plants usually flower during the second spring and then die after flowering. However, some plants may persist into a third year if sufficient energy reserves remain (Chipping 1994). Flowering occurs generally during May to July and occasionally extends into September or October (Magney 2006). Each flower head produces an average of 73 seeds up that are up to 4 mm (0.2 in) long (Turner and Herr 1996). (USFWS, 2014)

**Habitat Type**

Adult: Palustrine wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Bog/fen, herbaceous wetland (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations of 37 to 381 m (120 to 1,250 ft) (USFWS, 2014)

**Spatial Arrangements of the Population**

Adult: Colonies (USFWS, 2014)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 2014)

**Habitat Narrative**

Adult: Cirsium fontinale var. obispoense occupies perennial seeps and springs in serpentine soil and rock in western San Luis Obispo County, California (Figure 3). The plants usually occur on slopes, with existing records at 37 to 381 m (120 to 1,250 ft) elevation (CDFW 2013a). The plants often grow in colonies (spatial groups of presumably separate individuals). (USFWS, 2014)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are topped with a pappus (set of bristles) that aids in dispersal. (USFWS, 2014)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

22 (USFWS, 2022)

**Population Size:**

~10,000 (inferred from USFWS, 2014)

**Adaptability:**

Low (inferred from USFWS, 2014)

**Population Narrative:**

The taxon is currently known from 19 occurrences, and multiple colonies comprise most occurrences. The Service considers stochastic events, in particular drought, an ongoing threat. Because Cirsium fontinale var. obispoense is associated with seeps and springs, a severe or prolonged drought could reduce or eliminate its specialized habitat and result in the extirpation of some occurrences. Six occurrences have been reported to comprise more than 1,000 plants at particular points in time: occurrence 1 at San Simeon Creek (1,076 plants in 1993; CDFW 2013a), occurrence 2 at Laguna Lake Park (approximately 2,075 plants in 2006; M. Elvin, Service, pers. obs. 2006), occurrence 3 at Camp San Luis Obispo (1,872 plants in 2008; Holland 2009), occurrence 6 in the El Chorro Biological Reserve (2,200 plants in 1993; Chipping 1994), occurrence 10 at Miossi Creek (more than 1,000 plants in 1997; CDFW 2013a), and near Serpentine Lane (more than 4,000 plants in 2001; CDFW 2013a). The other 13 occurrences are each likely comprised of fewer than 1,000 plants in 2014, with the most recent estimates ranging from 0 to 800 plants per occurrence. (USFWS, 2014). In 2022, Chorro Creek bog thistle is known from 22 occurrences (CDFW 2021a, p. 1–2), with one of these possibly extirpated (occurrence 7). Nine occurrences are protected, but effectiveness for one of these (occurrence 12) is questionable, and 13 occurrences are not protected. To the best of our knowledge, all threats identified in USFWS (2014) and Kofron and Havlik (2016) still remain (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Road maintenance (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road maintenance (including grading, road expansion, mowing, herbicide application) and water diversions were identified as potential threats at that time (Wikler and Morey 1992). (USFWS, 2014)

**Stressor:** Invasive plants (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although the serpentine substrate is not conducive for most invasive plant species (Harrison et al. 2006.), Cortaderia (pampas grass) became established in the habitat and which the City of San Luis Obispo removed in 2010. Magney (2006) reported that the invasive Sonchus asper (prickly sow thistle) was invading the habitat and that it was being eradicated. Some occurrences are threatened by dense vegetation in and near the habitat, including native (E. macrostachya, Distichlis spicata (salt grass)) and invasive species (Helminthotheca echioides (bristly oxtongue), Centaurea calcitrapa (purple star-thistle), S. asper) (J. Olson, Colorado State University, pers. comm. 2012). (USFWS, 2014)

**Stressor:** Cattle grazing (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Several properties where Cirsium fontilae var. obispoense is found is zone for grazing. Light, controlled cattle grazing is conducted in some habitats, which appears to benefit Cirsium fontinale var. obispoense by reducing invasive plants (Siepel, pers. comm. 2012). (USFWS, 2014)

**Stressor:** Agriculture (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A small area (approximately 2 ha (5 ac)) of the property on the northern side of Chorro Creek is planted with row-crops, and likewise the adjacent property. This agriculture is in close proximity to Cirsium fontinale var. obispoense in Chorro Creek and is not compatible with its survival. (USFWS, 2014)

**Stressor:** Predation by insects (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Eurasian flower-head weevil has been reported predating Cirsium fontinale var. obispoense at several sites (Service 1994), including San Simeon Creek (Chipping 1994; Herr 2004), Laguna Lake Park (Herr 2004), and Camp San Luis Obispo (California Army National Guard 2012). In a study on one property at San Simeon Creek, 28 percent of the flower heads of Cirsium fontinale var. obispoense were infested throughout the plant's growing season, with 27 percent of the seeds destroyed on average in the predated flower heads. (USFWS, 2014)

**Stressor:** Herbivory by cattle (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There are two issues to consider regarding cattle grazing in and near the habitat of Cirsium fontinale var. obispoense: herbivory and trampling. Trampling by cattle while grazing in the habitat could severely damage established plants, especially when water becomes limited to the cattle and they congregate at the seep or spring. (USFWS, 2014)

**Stressor:** Stochastic events (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Species with small populations are vulnerable to extinction by stochastic events (Ricklefs 2008). This means that chance or random events can cause the population size of the species to decrease, possibly below the level of sustainability and down to extinction. We consider stochastic events, in particular drought, an ongoing threat. Because Cirsium fontinale var. obispoense is associated with seeps and springs, a severe or prolonged drought could reduce or eliminate its specialized habitat and result in the extirpation of some occurrences. (USFWS, 2014)

**Stressor:** Climate change (USFWS, 2014)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** We identify climate change as a new threat. Current climate change projections for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). We lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as isolation at perennial seeps and springs will affect Cirsium fontinale var. obispoense. However, limited-ranged taxa are likely to be more vulnerable to extinction due to these changing conditions. Our major concern is the effects of extreme weather events (e.g., severe drought, severe storm, harsh winter) due to climate change on the 19 occurrences of Cirsium fontinale var. obispoense. (USFWS, 2014)

***Recovery***

**Reclassification Criteria:**
1. Populations from throughout the range, each made up of multiple colonies, and their habitat at six sites are secure from human-induced threats, including water diversions or drawdowns. (USFWS, 1998)

2. At least three of these sites are in protected areas larger than 100 acres and populations are deemed viable and stable or increasing as determined by monitoring over a precipitation cycle that includes multiple years of below average rainfall. (USFWS, 1998)

3. Protected sites are being managed in a way that will support the continued existence of Cirsium fontinale var. obispoense and its wetland habitat. (USFWS, 1998)

4. Management is effective, as shown by at least 10 years of monitoring. (USFWS, 1998)

Recovery Priority Number: 9

**Delisting Criteria:**
When the downlisting criteria have been met for a species, the species can be considered for delisting if:

1. Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species (USFWS, 2019)

2. An ex situ seedbank is established in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that a occurrences could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019)

3. All existing occurrences are stable or increasing in the wild for at least 10 years. We expect above-ground occurrences size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA

2018). Ten occurrences were surveyed during the 5-year period from 2012 to 2016, which will provide a baseline for the status of these occurrences; these data should provide a basis for monitoring occurrence attributes to determine trajectory over time. (USFWS, 2019)

**Recovery Actions:**

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendation from 2014 5-Year Review: Additional occurrences of Cirsium fontinale var. obispoense likely exist in San Luis Obispo County, and also possibly in Monterey and Santa Barbara Counties. We recommend that searches be conducted in potentially suitable habitat with serpentine soil and rock in San Luis Obispo, Monterey and Santa Barbara Counties. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that the Service seek partnerships with the private landowners for assisting them to manage Cirsium fontinale var. obispoense on their properties. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that a range-wide census of the 19 occurrences be conducted in 2015 as a team effort including the California Army National Guard, the California Native Plant Society (San Luis Obispo Chapter), California Polytechnic State University, the City of San Luis Obispo, the private landowners, and the Service. The methods should be standardized in advance. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that the relevant biologists, landowners, and land managers monitor for invasive plant species in and near the habitat of Cirsium fontinale var. obispoense and take the necessary actions to eliminate this threat. (USFWS, 2014)

- Recommendation from 2014 5-Year Review: We recommend that any cattle grazing in the habitat of Cirsium fontinale var. obispoense be controlled and monitored. A controlled grazing regime may benefit Cirsium fontinale var. obispoense by reducing other vegetation (invasive and native) in and near the habitat and by providing favorable sites for the germination of seeds. Herbivory of Cirsium fontinale var. obispoense would be minor because their spiny characteristics make them generally unpalatable. However, trampling could severely damage the established plants, especially when water becomes limited to the cattle and they congregate in the seep or spring. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: The relevant biologists, landowners, and land managers should be aware of the introduced Eurasian flower-head weevil and the threat it poses to Cirsium fontinale var. obispoense. We recommend that they monitor for and report the presence of this introduced insect to the U.S. Fish and Wildlife Service, Ventura, California, and to the Department of Agriculture for San Luis Obispo County, California. (USFWS, 2014)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Coordinated conservation and research are needed to better understand the biology and ecology of Chorro Creek bog thistle, in particular to restore and maintain the existing occurrences. These efforts should include the following: • Conduct a more-detailed analysis of the status, threats, distribution, biology and ecology of Chorro Creek bog thistle, with a coordinated team effort including site visits by USFWS and partners. Priority should be given to visiting occurrences that have not been visited in the past 5 years. • Conduct modelling to anticipate the effects of climate change on distribution and abundance of Chorro Creek bog thistle, including changes in temperature and precipitation. • Implement management actions to benefit the individual occurrences of Chorro Creek bog thistle, including removing invasive and native plants that are threats. • Conserve and protect habitat in vicinity of and near the occurrences of Chorro Creek bog thistle. • Conduct searches for additional occurrences and locations of Chorro Creek bog thistle, with possible use of drones for searching large expanses of potential habitat and potential habitat in difficult terrain. In particular, U.S. Forest Service should search the upper reaches of Chorro Creek, Pennington Creek, San Luisito Creek and San Bernardo Creek on Los Padres National Forest (Keil 2022, p. 1). • Conduct a search to determine the precise location of occurrence 11, which is based on two herbarium specimens with imprecise location data (Kofron and Havlik 2016, p. 173). We suspect the location is near 35.275649/-120.603870. • Collect seeds for conservation seed banking. • Develop protocols for long-term restoration success. 1. Consider methods of Eckberg et al. (2017, p. 33–66). 2. In light of the threat of climate change with severe drought and increased temperatures, also consider methods for cultivating seeds for propagation and outplanting in arid lands used by Abella et al. (2012, entire), Abella et al. (2015, entire), Abella (2017, entire) and Abella et al. (2020, entire). • Introduce Chorro Creek bog thistle into living collections at several botanic gardens. (USFWS, 2022)

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# SPECIES ACCOUNT: *Cirsium hydrophilum var. hydrophilum* (Suisun thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/20/1997; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

A perennial herb with erect stems, usually 1-1.5 m tall, and with spiny, deeply lobed leaves. Pale lavender or pink flower heads, 2-2.5 cm long, are borne singly or in loose groups. In the pre-flowering phase, it grows as a short, broad, vegetative rosette with large leaves, approximately 0.3 to 0.9 m long. Stems are typically branched above the middle of the main stem, but up to 15 stems may occasionally branch from the base of single large plants (P. Baye unpubl. data 2000). Leaves on stems are much smaller, more deeply lobed, and spinier than juvenile leaves of the rosette. The egg-shaped flowerheads (2.5 cm) are composed of small individual florets united into a single unit. Flowerheads occur either as solitary units or in clusters. The bracts of the flowerheads have a distinct green, glutinous ridge on the back that distinguishes C. hydrophilum var. hydrophilum from other Cirsium species in the area. (USFWS, 2013)

**Taxonomy**

Cirsium hydrophilum var. hydrophilum was originally described as Cnicus breweri Gray var. vaseyi Gray (Gray 1888). Cnicus breweri is a taxon now placed in Cirsium douglasii DC var. breweri (A. Gray) (Keil and Turner 1993). Subsequent synonyms, now invalid, include Carduus hydrophilus Greene (Greene 1892) and Cirsium vaseyi (Gray) Jepson var. hydrophilum (Greene) Jepson (Jepson 1925). Jepson (1901) was the first to apply the combination Cirsium hydrophilum. The species Cirsium hydrophilum, as now interpreted, (Howell 1969, Keil and Turner 1993) comprises two morphologically similar varieties: C. hydrophilum var. vaseyi, (synonym: Cirsium vaseyi [A. Gray] Jepson), a related rare thistle endemic to seeps in serpentine soils on Mount Tamalpais, Marin County, and C. hydrophilum var. hydrophilum, endemic to brackish tidal marshes in Suisun Marsh, Solano County. (USFWS, 2013)

**Historical Range**

Not available

**Current Range**

Cirsium hydrophilum var. hydrophilum is only known from locations in Suisun Marsh.

**Critical Habitat Designated**

Yes; 4/12/2007.

**Legal Description**

On April 12, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cirsium hydrophilum var. hydrophilum (Suisun thistle) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (72 FR 18518-18553).

**Critical Habitat Designation**

The critical habitat designation forCirsium hydrophilum var. hydrophilum includes three CHUs in Solano County, California. This species critical habitat encompasses approximately 2,052 acres (ac) (830 hectares (ha)) (72 FR 18518-18553).

Unit 1: Hill Slough Marsh: Unit 1 consists of approximately 525 ac (213 ha) located north of Potrero Hills between Grizzly Island Road and Highway 12. As discussed in ‘‘Criteria Used to Identify Critical Habitat for Cirsium hydrophilum var. hydrophilum’’ above, this unit is currently unoccupied and was unoccupied at the time of listing, but it is essential to the conservation of the subspecies because it is the single best area for establishment of an additional population (see response to Comment 2). It contains all the necessary PCEs and is the subject of ongoing planning and restoration efforts within the Suisun Marsh. The unit consists of approximately 440 ac (178 ha) of Stateowned land (Hill Slough Wildlife Area), which is managed by the CDFG, and 85 ac (35 ha) of privately owned land. The unit receives tidal inundations irregularly (not daily) (NWI 2005) from Hill Slough and a flood control channel along the western unit boundary.

Unit 2: Peytonia Slough Marsh: Unit 2 consists of approximately 346 ac (140 ha) of tidal marsh (PCE 1) located adjacent to Cordelia Road to the west, Suisun Slough to the east, Peytonia Slough to the south, and Suisun City to the north. The unit consists of approximately 192 ac (78 ha) of State-owned land (Peytonia Slough Ecological Reserve), which is managed by the CDFG, and 154 ac (62 ha) of privately owned high tidal marsh. Although the unit is bisected, north to south, by an elevated railroad line, much of the track is on trestle rather than berm, allowing tidal waters to reach both sides of the unit through Peytonia Slough and several smaller unnamed sloughs (NWI 2005; Vollmar 2005a, pp. 2, 3, 5; Huffman 2006, p. 1). Because of this hydrological connection, we are treating designated habitat on both sides of the track as a single unit, rather than splitting it into two subunits as we did in the proposed designation. Cirsium hydrophilum var. hydrophilum occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. hydrophilum var. hydrophilum.

Unit 3: Rush Ranch/Grizzly Island Wildlife Area: Unit 3 consists of approximately 1,181 ac (477 ha) of tidal marsh located adjacent to Suisun Slough to the west, Cutoff and Montezuma Sloughs to the south, and Potrero Hills to the North. This unit consists of 231 ac (93 ha) of State-owned land (the Joice Island portion of Grizzly Island Wildlife Area), which is managed by the CDFG, and 950 ac (384 ha) of land owned by the Solano Land Trust (local nonprofit public land trust). Cirsium hydrophilum var. hydrophilum occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. hydrophilum var. hydrophilum. The unit receives regular tidal inundations at least once daily (NWI 2005) from the abovementioned tidal sloughs. Additional special management considerations or protection beyond the special management required for common threats, as discussed above, may be required to control the presence of Rhinocyllus conicus (a nonnative biological control weevil) or other planteating insects that could reduce the reproductive potential of C. hydrophilum var. hydrophilum.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cirsium hydrophilum var. hydrophilum critical habitat consists of three components (72 FR 18518-18553):

(i) Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);

(ii) Open channels that periodically contain moving water with oceanderived salts in excess of 0.5 percent; and

(iii) Gaps in surrounding vegetation to allow for seed germination and growth.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing and that contain the PCEs may require special management considerations or protection. Most of the PCEs and the known occurrences of Cirsium hydrophilum var. hydrophilum and Cordylanthus mollis ssp. mollis are threatened by: (1) tidal wetland conversions to diked, managed, or muted tidal marshes; (2) changes to channel water salinity and tidal regimes; (3) mosquito abatement activities; (4) marsh invasions by nonnative plants; (5) plant-eating insects; (6) urban, industrial, and agricultural encroachment; (7) impacts from livestock overgrazing; (8) feral pigs (Sus scrofa); and (9) impacts from unauthorized foot and off-road vehicle traffic. These combined threats result in the loss and fragmentation of suitable habitat for C. hydrophilum var. hydrophilum and C. mollis ssp. mollis, which could significantly affect their long-term survival. Individually, these threats may require special management considerations or protection as addressed under the critical habitat unit descriptions below.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (vegetative) (USFWS, 2013)

**Lifespan**

Adult: 1 year (USFWS, 2013)

**Dependency on Other Individuals or Species**

Adult: Bees and insects (USFWS, 2009)

**Breeding Season**

Adult: July to September (USFWS, 2009)

**Reproduction Narrative**

Adult: Cirsium hydrophilum var. hydrophilum is an annual plant, dying after one year of seed reproduction. Its vegetative period is usually one year (biennial), but if small vegetative plant size or unfavorable environmental conditions delay flowering, it may regenerate from the central root crown for more than one year. Pale lavender-rose flower heads appear between July and September. Flowering plants may produce hundreds of seed heads. Seed heads observed in July 2000 had three to five ripe seeds per head, but many of them contained aborted seeds or were found with insect larvae in active seed predation (Baye 2000). Specific flower pollinators of Cirsium hydrophilum var. hydrophilum have not been directly studied; however, field observations indicate that several bee species may be important in pollinating the species (LCLA 2003). The most common insect species observed gathering pollen at Rush Ranch was the yellow-faced bumble bee (Bombus vosnesenskii) (LCLA 2003). (USFWS, 2009; USFWS, 2013)

**Habitat Type**

Adult: Tidal marsh (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Restricted to regularly flooded and permanently saturated habitats within 50 to 100 feet of the high water mark of tidal channels (USFWS, 2009)

**Spatial Arrangements of the Population**

Adult: Discrete colonies or clusters of small patches (USFWS, 2013)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: The dispersion pattern of C. hydrophilum var. hydrophilum (California Department of Water Resources in litt. 1996) in discrete colonies or clusters of small patches suggests there may be limited seed dispersal. Most known Cirsium hydrophilum var. hydrophilum occurrences are found in regularly flooded and permanently saturated habitats, along the banks of canals or ditches, within 50 to 100 feet of the high water mark of natural tidal channels; and on tidal floodplains within tidal marshes (U.S. Fish and Wildlife Service 2007). (USFWS, 2009; USFWS, 2013)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (USFWS, 2013)

**Dispersal**

Adult: Low (USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: The dispersion pattern of C. hydrophilum var. hydrophilum (California Department of Water Resources in litt. 1996) in discrete colonies or clusters of small patches suggests there may be limited seed dispersal. (USFWS, 2013)

***Population Information and Trends***

**Population Trends:**

Long-term decline of 50 - 70% (NatureServe, 2015)

**Number of Populations:**

4 (USFWS, 2009)

**Population Size:**

22,300 to 873,200 individuals, with a best estimate of 137,500 individuals (LCLA 2003). (USFWS, 2013)

**Adaptability:**

Low (USFWS, 2009)

**Population Narrative:**

It was once widespread in Suisun Marsh, but, due to habitat loss, in the last two decades has been found in only four localities: Grizzly Island, Peytonia Slough, Rush Ranch, and Hill Slough. These populations have been in decline in the 1990s and 2000s. The species was considered to belong to a large, single population of approximately 22,300 to 873,200 individuals, with a best estimate of 137,500 individuals (LCLA 2003) in a recent comprehensive survey in 2003. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, oil spills, genetic or demographic problems or a combination of these events. Long-term trends suggest a decline of 50-70% due to massive changes in the Suisun Marsh due to water projects and utilization. (USFWS, 2009; USFWS, 2013; NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Alteration of tidal regime (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Diking and filling involved in agricultural land conversion and urbanization, ditching for mosquito abatement, changes to freshwater inflow, and habitat fragmentation are threats to Cirsium hydrophilum var. hydrophilum. Private lands continue to experience development (Grewell, pers. comm. 2007). Derelict and actively maintained levees from historic diking practices continue to result in muted (damped) tidal flows, which in turn, reduce available habitat for C. hydrophilum var. hydrophilum. Alteration of natural tidal cycles still exists in much of the potential habitat and represents both the most significant historic and current threat to Cirsium hydrophilum var. hydrophilum and its habitat. With respect to effects to C. hydrophilum var. hydrophilum, alteration of tidal cycles includes muting of tidal flows, increases in freshwater runoff and diversion of freshwater for agricultural and municipal uses. A large portion of historic tidal marshes in Suisun Bay were diked and managed for waterfowl. These historic reductions of habitat have affected the extent and composition of tidal marsh communities. The brackish tidal wetlands in Rush Ranch have been ditched extensively to drain standing water, in an effort to reduce mosquito breeding habitat. Ditching has greatly altered the hydrology of the marsh, primarily because the ditches cut across natural drainage patterns. As a result, mosquito ditches have led to the reduction of tidal inundation and the consequent infilling of first order channels, creating new mosquito breeding habitat (Collins et al. 1986, WRA et al. 1989). Originally, ditching may have reduced Cirsium hydrophilum var. hydrophilum habitat by reducing tidal influence in first order channels. However, the mosquito ditching currently provides new, artificial habitat for C. hydrophilum var. hydrophilum similar enough to first order channels to promote colonization of these ditches. (USFWS, 2009)

**Stressor:** Feral pigs (USFWS, 2009)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** The threat from feral hogs (Sus scrofa) to Cirsium hydrophilum var. hydrophilum was not described in the listing rule, however, it is a present threat at both known locations of the species. Thirty-four percent of the C. hydrophilum var. hydrophilum subpopulations at Rush Ranch showed signs of damage due to rooting and trampling of feral pigs when surveyed in 2003 (LCLA 2003). Further, disturbances on the landscape created by feral pigs may enhance colonization opportunities for a non-native plant Lepidium latifolium (perennial pepperweed), to threaten the tidal marsh ecosystem, discussed further under Factor E (LCLA 2003). (USFWS, 2009)

**Stressor:** Sea-level rise (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of Cirsium hydrophilum var. hydrophilum. Conservation of high marsh zones in the face of sea level rise requires landward transgression (displacement) of the marsh profile on broad, sloping plains (Field et al. 1999, Baye 2006). If the sea level rises, conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could not support C. hydrophilum var. hydrophilum habitat (Grewell 2006). (USFWS, 2009)

**Stressor:** Thistle weevil (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The presence of a thistle weevil (Rhinocyllus conicus) in a portion of the Cirsium hydrophilum var. hydrophilum population was stated to be a possible threat to the species. This threat was discovered by California Department of Water Resources in June 1996 when the weevil was collected inside C. hydrophilum var. hydrophilum flower heads, many of which had no seeds (U.S. Fish and Wildlife Service 1997). The larval stage of this weevil is known to feed on seeds. Plant-eating insects can significantly limit seed production and plant demography as seen in several other Cirsium species (Louda and Potvin 1995; Palmisano and Fox 1997; Rose et al. 2005). (USFWS, 2009)

**Stressor:** Caterpillars (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Phyciods mylitta caterpillars were collected on a population of C. hydrophilum var. hydrophilum in September 1996. These caterpillars have caused significant damage to the rosettes of plants that will flower the following year (U.S. Fish and Wildlife Service 1997). Though documented in the listing rule to have occurred previously at Rush Ranch, Phyciods mylitta caterpillars were not located there during LCLA’s 2003 study. (USFWS, 2009)

**Stressor:** Non-native plants (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** All known populations of Cirsium hydrophilum var. hydrophilum are negatively affected by nonnative plants. The most problematic and widespread invasive plant in Suisun Marsh is the perennial herb, Lepidium latifolium (Grewell 2005). It occurs along the high marsh edge of San Francisco Bay, especially in disturbed areas, deposits of sand or tidal litter, or levee slopes. In brackish marshes with lower salinity, it invades the middle marsh plain and channel edges. Lepidium latifolium forms large monotypic patches that displace native marsh vegetation (Renz 2000). As much as 40 percent of L. latifolium biomass is below-ground, with most of it concentrated in the upper 24 inches (Renz 2000). This concentration of biomass in surface roots enhances the weed's competitiveness for water and nutrients. Further, as well as being a prolific seed producer, its roots fragment easily and can sprout even after exposure on the soil over the winter. Root fragments also can be carried by water and establish new populations where they are deposited (Renz 2000). (USFWS, 2009)

**Stressor:** Hybridization (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hybridization with Cirsium vulgare, a non-native, also is a potential threat to Cirsium hydrophilum var. hydrophilum. Hybridization with C. vulgare was suggested as a possible explanation for the previously presumed extinction of C. hydrophilum var. hydrophilum (Smith and Berg 1988). Though recent studies have indicated that the two species coexist at Rush Ranch, no genetic studies have been conducted since the time of listing to determine if hybridization has indeed occurred. L.C. Lee and Associates (2003) found that 45 percent of C. hydrophilum var. hydrophilum subpopulations at Rush Ranch contained C. vulgare. It is known that C. vulgare hybridizes readily with other Cirsium species. (USFWS, 2009)

**Stressor:** Chronic pollution (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oil spills and chronic pollution from point and non-point sources (heavy metal contamination from point and non-point sources) continue to occur in or near habitat for Cirsium hydrophilum var. hydrophilum (U.S. Fish and Wildlife Service 2007). On April 27, 2004, Kinder Morgan Energy Partners, L.P. spilled 123,774 gallons of diesel fuel through a ruptured pipeline in western Suisun Marsh near Roos Cut. The spill occurred within known habitat for C. hydrophilum var. hydrophilum and contaminated 225 acres of the marsh to varying degrees (Solano County 2005). It is not known whether populations of C. hydrophilum var. hydrophilum were directly affected. (USFWS, 2009)

**Stressor:** Fire (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is not known how fire affects the viability of Cirsium hydrophilum var. hydrophilum or its seed, but it is considered a minor threat nonetheless. Human-caused fires present a

continual threat of at least temporary habitat loss in Suisun Marsh. Three fires have occurred recently within existing and potential C. hydrophilum var. hydrophilum habitat in Suisun Marsh (Grewell pers comm. 2007). Arsonists set fire in 2001 to a large portion of Peytonia Slough Ecological Reserve, burning all vegetation from Suisun Slough to the Southern Pacific Railroad tracks, including the only remaining previously known population at Peytonia Slough Ecological Reserve. (USFWS, 2009)

**Stressor:** Random events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, oil spills, genetic or demographic problems or a combination of these events. (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. The minimum area inhabited annually by the species must be 2,000 acres over a period of five years. (USFWS, 2013)

2. A minimum of 4,000 acres must be permanently preserved and under protective management. This must include existing or successfully restored tidal marsh areas with suitable habitat for the species and encompass a minimum of 80 percent of the extant occurrences of the species. (USFWS, 2013)

3. Reduction in extant Lepidium latifolium populations in tidal areas of Suisun Marsh (in and down-gradient of the high marsh-upland ecotone) to less than ten percent cover for five years. (USFWS, 2013)

4. Natural tidal range must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic tidal flooding. (USFWS, 2013)

5. At least three separate populations or one large population must occur within Suisun Marsh. Required target number of individuals is dependent on whether separate populations are easily identifiable, as described below. A population shall be any concentration of plants with closest individuals to other populations greater than 1 kilometer (0.6 mile) apart over a period of five years. (USFWS, 2013)

6. Over five years of monitoring, a mean of at least 3,000 individuals must occur annually over the entire range of the species. The third-largest separate population over the same period must have a mean of at least 300 individuals. If there are fewer than three separate populations, a mean of at least 5,000 individuals must occur annually throughout the entire range of the species over a period of five years. The entire species must not fall below 800 individuals for two consecutive years over a period of five years. (USFWS, 2013)

Recovery Priority Number: 3C

**Delisting Criteria:**
1. The minimum area inhabited annually by the species must be 3,000 acres over a period of eight years. (USFWS, 2013)

2. A minimum of 6,000 acres of suitable habitat must be permanently preserved and under protective management. This must include existing or successfully restored tidal marsh areas with suitable habitat for the species and encompass a minimum of 80 percent of the species, as well as habitat supporting adequate self-sustaining populations of pollinators. (USFWS, 2013)

3. All conditions under downlisting criterion number 3 have been met. In addition, a plan must be developed and implemented for early detection and control of Lepidium latifolium following any future increase beyond ten percent cover in tidal areas of Suisun Marsh (in and down-gradient of the high marsh-upland ecotone). Also, a funding source must be secured to fund such actions in perpetuity. (USFWS, 2013)

4. All conditions under downlisting criterion number 4 have been met. (USFWS, 2013)

5. Reliable propagation and reintroduction methods must be developed and available. (USFWS, 2013)

6. Trampling and rooting damage to Cirsium hydrophilum var. hydrophilum by feral pigs must have been eliminated at all populations for five years. (USFWS, 2013)

7. Unnaturally high seed predator pressures on C. hydrophilum var. hydrophilum from thistle weevil (Rhinocyllus conicus) must fall below a level at which it negatively affects long-term population persistence. (USFWS, 2013)

8. At least four separate populations must occur within Suisun Marsh. Over eight years of monitoring, a mean of at least 4,000 individuals must occur annually, spread across at least four populations and the fourth-largest population over the same period must have a mean of at least 500 individuals. If not divisible into separate populations, a mean of at least 7,000 individuals must occur annually throughout the entire range of the species over a period of eight years. The entire species must not fall below 1,000 individuals for two consecutive years over a period of eight years. (USFWS, 2013)

9. Seed banking of all extant populations and representative genetic diversity (per commonly accepted seed banking protocols) must be complete. (USFWS, 2013)

10. Research must be conducted to determine if hybridization is occurring between Cirsium hydrophilum var. hydrophilum and Cirsium vulgare. If research shows that hybridization is occurring, extant C. vulgare populations must be eliminated in Suisun Marsh and a monitoring plan must be in place to detect and eliminate future infestations of C. vulgare. (USFWS, 2013)

11. To minimize impacts sustained after oil spills occurring at or near populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of Cirsium hydrophilum var.

hydrophilum. (USFWS, 2013)

12. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. (USFWS, 2013)

**Recovery Actions:**

- Short-term recovery actions should be implemented concurrently with long-term habitat restoration and should focus on protecting and managing existing populations and habitats. Recovery strategies include: suppression of invasive non-native plant species, protection and management of nearby native bee and wasp habitats, control of Cirsium vulgare, if research indicates necessity, restoration of normal tidal range and salinity, seed banking of Cirsium hydrophilum var. hydrophilum, monitoring of populations and habitat, and research aspects of life history, population ecology, and seed predation of C. hydrophilum var. hydrophilum. (USFWS, 2013)
- A recovery plan for Cirsium hydrophilum var. hydrophilum should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft recovery plan for this species and five other listed tidal marsh species is currently in development by the Service. (USFWS, 2009)
- Natural tidal cycles should be maintained (and restored at Hill Slough and the ponded area of Rush Ranch) because the middle to high marsh area, with periodic tidal flooding, is vital to Cirsium hydrophilum var. hydrophilum. (USFWS, 2009)
- Control of Lepidium latifolium should be conducted at Peytonia Slough Ecological Reserve, Rush Ranch, Hill Slough, Grizzly Island Wildlife Area, as appropriate, to reduce competition with Cirsium hydrophilum var. hydrophilum. (USFWS, 2009)
- Research should be conducted to determine whether hybridization is occurring between Cirsium hydrophilum var. hydrophilum and Cirsium vulgare at Rush Ranch. (USFWS, 2009)
- Research should be conducted to determine the extent to which seed predation by Rhinocyllus conicus is negatively affecting populations of Cirsium hydrophilum var. hydrophilum. If a substantial threat exists, research into effective means of Rhinocyllus conicus control should be researched and implemented at appropriate sites. (USFWS, 2009)
- Surveys should be conducted within potential Cirsium hydrophilum var. hydrophilum habitat as well as at known population centers to identify potential new occurrences as well as to provide an updated species status with which to make management decisions. Specifically, Peytonia Slough Ecological Reserve should be surveyed to determine if that population is extant and the Hill Slough area should be more extensively surveyed to determine the abundance of C. hydrophilum var. hydrophilum there. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Several areas of future action over the next five years are suggested, which build on the actions articulated in Service (2013) and the tidal marsh ecosystem sections of Service (2019a, 2019b). Consider developing, reviewing and implementing the following survey and monitoring plans: • A range-wide Cirsium hydrophilum var. hydrophilum survey and monitoring plan. This plan would include locations to be surveyed; the group(s) responsible for coordinating surveys; survey timing including the month(s) surveys are to be conducted; and the frequency of surveys (e.g., annually vs. every three years). These surveys should be conducted by well-trained individuals capable of reliably identifying Cirsium hydrophilum var.

hydrophilum, should be reproducible, and should provide at a minimum the following information: an estimated population size with confidence interval(s); the number and locations of known populations; an estimate of the area inhabited by Cirsium hydrophilum var. hydrophilum (acres); and an estimate of the area inhabited by Cirsium hydrophilum var. hydrophilum that occurs on preserved properties (acres). • A Lepidium latifolium survey and monitoring plan for areas occupied by Cirsium hydrophilum var. hydrophilum. This would include locations to be surveyed; the group(s) responsible for coordinating surveys; survey timing including the month(s) surveys are to be conducted; and the frequency of surveys. These surveys should be reliable and reproducible and at a minimum provide an estimate of the percent of the total distribution of Cirsium hydrophilum var. hydrophilum in which Lepidium latifolium also occurs. • A range-wide thistle weevil predation pressure monitoring plan for Cirsium hydrophilum var. hydrophilum. This plan would include information about how predation pressure will be estimated, the group(s) responsible for coordinating monitoring, and locations to be monitored including the timing and frequency of predation pressure surveys. • A feral pig and cattle damage monitoring plan to evaluate the extent of feral pig and cattle damage to Cirsium hydrophilum var. hydrophilum populations. This plan would include information about how feral pig and cattle activity and damage will be monitored, the group(s) responsible for coordinating surveys, locations to be surveyed for damage including survey timing, and the frequency of damage surveys. Consider developing and implementing the following Cirsium hydrophilum var. hydrophilum restoration actions: • A tidal marsh restoration plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. • An upland marsh restoration plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. • A propagation and reintroduction plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. • A seed banking plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. Other future actions to consider include continued research on the habitat requirements and seed bank dynamics of Cirsium hydrophilum var. hydrophilum, which may lead to helpful information and insights in guiding long-term recovery efforts, including identifying areas for possible development of new populations of Cirsium hydrophilum var. hydrophilum within Suisun Marsh. This future work could include an analysis of how environmental variables, such as precipitation and temperature patterns, and seeding and out-planting influence population dynamics in currently occupied areas and colonization of newly restored areas. A study of the current pollinators of Cirsium hydrophilum var. hydrophilum would help add to the Service's understanding of the natural history of this plant and identify which potential pollinators, or groups of pollinators, to monitor to ensure that healthy and diverse pollinator populations continue to occur. Statistical and numerical modeling, such as with habitat suitability analysis and population dynamics modeling, can provide insights into possible locations to search for unknown populations of Cirsium hydrophilum var. hydrophilum and for identifying future locations for development of new populations, and future dynamics of these populations. Vasey et al. (2020) began developing a species distribution model for Cirsium hydrophilum var. hydrophilum. It is possible that a continuation of this line of investigation will lead to improved insights into where and how to develop additional areas that will support the recovery of Cirsium hydrophilum var. hydrophilum. It may also be useful to consider developing population viability analyses (PVA) that are specifically developed for Cirsium hydrophilum var. hydrophilum. For example, it is possible that a stage-structured matrix population model similar to the model developed by Thomson (2005; also see Gotelli 2001, Kéry and Schaub 2012) could be used to form a foundation for PVA analysis. It is also possible that building and parameterizing such a model, and then projecting this model into various possible futures, including under the influence of changing climate and hydrology conditions, could help provide useful insights. As part of efforts to improve statistical analysis and modeling, creating a well-vetted and archived dataset of all Cirsium hydrophilum var. hydrophilum surveys, and resolving any discrepancies in counts identified during this review will be critical to progressing on this objective. The San Francisco Bay-Delta Fish and Wildlife Office has convened a recovery implementation team (RIT) to focus on the listed tidal marsh species described in Service (2013), including Cirsium hydrophilum var. hydrophilum. The primary goal of this group is to encourage Service biologists, managers and external experts to collectively consider recovery priorities for these species and tidal marsh ecosystems in northern and central California, and continue to stay abreast of emerging research related to Cirsium hydrophilum var. hydrophilum and related tidal marsh taxa, tidal marsh ecology, and other relevant topics. This group could help develop a recovery implementation strategy for Cirsium hydrophilum var. hydrophilum, which would strive to articulate relatively short-term recovery goals (e.g., on a 2-3 year time horizon) related to the long-term recovery criteria discussed in detail above and in Service (2013). (USFWS, 2021)

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# SPECIES ACCOUNT: *Cirsium loncholepis* (La Graciosa thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 04/19/2000; California/Nevada (Region 8)

**Physical Description**

a biennial or short-lived perennial plant that flowers once and then dies (Lea 2002, p. 67; Teed 2003, p. iv; Baldwin et al. 2012, p. 289), with a probable life span of 2 to 6 years (Lea 2002, p. 68). It is an erect or spreading mound-like plant with spines on the leaves and flower heads. The plants have one or more stems that range usually from 10 to 100 cm/4 to 39 in tall but occasionally up to 150 cm/59 in. The lower leaves are 10 to 30 cm/4 to 12 in long with spiny petioles (leaf stalks) and usually deeply lobed with secondary lobes or teeth. The leaves have a wavy edge, with the bases of the middle and upper leaves forming short, spiny wings along the petiole. Flower heads are 2 to 4 cm/0.8 to 1.6 in wide in tight clusters and at the tips of stems. The flowers are 25 to 30 mm/1.0 to 1.2 in long, and nearly white with a purplish tube containing purple anthers (Figure 2). The fruits are achenes (dry fruit containing one seed only; Lea 2002, p. 7), 3 to 4 mm/0.1 to 0.2 in long, and topped with a pappus (umbrella of small hairs) 15 to 25 mm/0.6 to 1.0 in long (Keil and Turner 1993, p. 236) that facilitates wind dispersal. La Graciosa thistle can be confused with the clustered thistle (Cirsium brevistylum; Table 3) and cobwebby thistle (Cirsium occidentale). (USFWS, 2018)

**Taxonomy**

Cirsium loncholepis was described and named by Petrak (1917, p. 375) from a specimen collected “near La Graciosa” by Alice Eastwood in 1906. It is in the aster and sunflower family (Asteraceae; Baldwin et al. 2012, p. 289). The common name La Graciosa thistle is in reference to the collection site of the holotype, which apparently was near Graciosa railway station or La Graciosa village (now south Orcutt; Figure 1) in Santa Barbara County (Wilken 2009, p. 3). (USFWS, 2018)

**Historical Range**

See Current Range.

**Current Range**

La Graciosa thistle is associated with wetland features such as dune swales, dune slack ponds, and dune lakes within the Guadalupe-Nipomo Dunes Complex, in western San Luis Obispo County, on the Central Coast of California. Historically, it also occurred in other wetland feature types including marshes, seeps, intermittent streams, mesic floodplains, and river margins within the riparian habitats of the Santa Maria River and a few other, more isolated areas within northern Santa Barbara County (USFWS, 2024)

**Critical Habitat Designated**

Yes; 12/3/2009.

**Legal Description**

On November 3, 2009, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 3, 2009) for Cirsium loncholepis (La Graciosa thistle) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (74 FR 56978-57046).

**Critical Habitat Designation**

The critical habitat designation for Cirsium loncholepis includes six CHUs in San Luis Obispo and Santa Barbara Counties, California. This species critical habitat encompasses approximately 24,103 acres (ac) (9,754 hectares (ha)). Brief descriptions are provided below; detailed coordinates and maps are included in the Final Rule (74 FR 56978-57046; USFWS, 2009).

Unit 1: Callender-Guadalupe Dunes (9,690 ac (3,921 ha)) Unit 1 is located in the southwestern corner of San Luis Obispo County, California. It stretches along 8.5 mi (13.5 km) of coast from Arroyo Grande Creek to the Santa Maria River. This unit is south of Pismo Beach, west of Nipomo and north of Guadalupe.

Unit 2: Santa Maria River-Orcutt Creek (13,227 ac (5,353 ha)) Unit 2 is located along the lower 5 mi (8 km) of the Santa Maria River and along the length of Orcutt Creek (approximately 13 mi (21 km)) in San Luis Obispo and Santa Barbara Counties, California.

Unit 3: Canada de las Flores (740 ac (299 ha)) Unit 3 is located approximately 5 mi (8 km) northwest of the town of Los Alamos and southwest of the Solomon Hills in Santa Barbara County, California.

Unit 4: San Antonio Creek (185 ac (75 ha)) Unit 4 is located in the northwestern portion of Santa Barbara County, California. The majority of Unit 4 lands occur on VAFB.

Unit 5: San Antonio Terrace (52 ac (21 ha)) Unit 5 is located in western Santa Barbara County, California. We determined that all lands in Unit 5 (7,334 ac (2,968 ha)) on San Antonio Terrace are essential to the conservation of Cirsium loncholepis. Unit 5 stretches along 4 mi (6.5 km) of the coast north from San Antonio Creek.

Unit 6: Santa Ynez River (210 ac (85 ha)) Unit 6 is located in the western portion of Santa Barbara County, California. Unit 6 is west of Lompoc and east of Surf.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cirsium loncholepis critical habitat consists of four components (74 FR 56978-57046):

(i) Mesic areas associated with: (A) Margins of dune swales, dune lakes, marshes, and estuaries that are associated with dynamic (changing) dune systems including the Santa Maria Valley Dune Complex and Santa Ynez Valley Dune Complex; (B) Margins of dynamic riparian systems including the Santa Maria and Santa Ynez Rivers and Orcutt and San Antonio Creeks; and (C) Freshwater seeps and intermittent streams found in other habitats, including grassland, meadow, coastal scrub, and oak woodland. These areas provide space needed for individual and population growth including sites for germination, reproduction, seed dispersal, seed bank, and pollination;

(ii) Associated plant communities including: Central dune scrub, coastal dune, coastal scrub, freshwater seep, coastal and valley freshwater marsh and fen, riparian scrub (e.g., mule fat scrub, willow scrub), oak woodland, intermittent streams, and other wetland communities, generally in association with the following species: Juncus spp. (rush), Scirpus spp. (tule), Salix spp. (willow), Toxicodendron diversilobum (poison oak), Distichlis spicata (salt grass), Baccharis pilularis (coyote brush), and B. douglasii (Douglas' baccharis);

(iii) Soils with a sandy component including but not limited to dune sands, Oceano sands, Camarillo sandy loams, riverwash, and sandy alluvial soils; and

(iv) Features that allow dispersal and connectivity between populations, particularly: (A) Natural riparian drainages in Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River that are not channelized or confined by barriers or dams, such that they have soft bottoms and sides and a natural flood plain (allowing uninterrupted water flows); and (B) Natural aeolian geomorphology in the Santa Maria Dune Complex and Santa Ynez Dune Complex, and along the Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River drainages that is not confined by barriers or wind-blocks such as large manmade structures, tree rows, or windbreaks (allowing uninterrupted winds across these areas).

**Special Management Considerations or Protections**

Many of the known occurrences of Cirsium loncholepis are threatened by direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup); development that results in additional habitat modification or land use changes (i.e., conversion of agricultural and urban development); county zoning changes; issuance of development permits; non point source pollution such as from urban and agricultural runoff (e.g., herbicides, fertilizers); facility accidents by oil companies or VAFB; groundwater extraction throughout the range of the species; hydrological alterations; direct and indirect effects from off highway vehicle (OHV) activity (i.e., habitat disturbance, hazardous materials spills); small population size; and habitat fragmentation and loss through the invasion of aggressive nonnative weeds such as Ammophila arenaria (European beach grass), Carpobrotus spp. (iceplant), Ehrharta calycina (veldt grass), and Mesembryanthemum crystallinum (crystalline iceplant). These threats may require special management to ensure the long-term conservation of C. loncholepis.

The essential features found in Unit 1 may require special management considerations or protection resulting from: (1) direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup, facility accidents); (2) ground water extraction which lowers the water table, dries the wetlands, and can destroy surface and subsurface hydrologies; (3) stochastic (i.e., random) extirpation/extinction events that occur because the population size is small or isolated; (4) trampling and grazing from trespass of cattle; (5) competition from invasive, aggressive, nonnative weeds (e.g., Ammophila arenaria , Carpobrotus spp., Ehrharta calycina, Mesembryanthemum crystallinum); (6) direct and indirect effects from OHV activity (i.e., habitat disturbance, hazardous materials spills); (7) habitat fragmentation; and (8) nutrient inputs in the water systems that are above concentrations known to adversely affect freshwater ecosystems and cause adverse ecological effects including altering the composition of the plant community and inducing biostimulation.

The essential features found in Unit 1 may require special management considerations or protection resulting from: (1) direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup, facility accidents); (2) ground water extraction which lowers the water table, dries the wetlands, and can destroy surface and subsurface hydrologies; (3) stochastic (i.e., random) extirpation/extinction events that occur because the population size is small or isolated; (4) trampling and grazing from trespass of cattle; (5)

competition from invasive, aggressive, nonnative weeds (e.g., Ammophila arenaria , Carpobrotus spp., Ehrharta calycina, Mesembryanthemum crystallinum); (6) direct and indirect effects from OHV activity (i.e., habitat disturbance, hazardous materials spills); (7) habitat fragmentation; and (8) nutrient inputs in the water systems that are above concentrations known to adversely affect freshwater ecosystems and cause adverse ecological effects including altering the composition of the plant community and inducing biostimulation.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 2-3 years (inferred from USFWS, 2011)

**Dependency on Other Individuals or Species**

Adult: Pollinators (potential pollinators include ants, beetles, bees, flies, and butterflies( (USFWS, 2024)

**Breeding Season**

Adult: Blooms from April to September (USFWS, 2018)

**Other Reproductive Information**

Adult: La Graciosa thistle blooms from April to September (Baldwin et al. 2012, p. 289). Potential pollinators include ants, beetles, bees, butterflies and flies (Keil 2001, p. 1; Lea 2002, p. 80). Seed dispersal is by wind (Keil and Turner 1993, p. 236; Lea 2002, p. 7; USFWS 2016a, p. 68) and also likely by water because it is a wetland plant. The seed bank of La Graciosa thistle may be similar to that of the wetland jewelweed (Impatiens capensis) for which no persistent seed bank exists (Simpson et al. 1985, p. 307). This is supported by the data in our Table 2. Of the 13 occurrences for which zero plants were recorded and then a subsequent census conducted, 11 also had zero plants recorded in the subsequent census. In other words, only two of 13 occurrence were found to be extant after a previous census record of zero plants. This combined with the observations of Hendrickson (1990b, p. 23), Lea (2002, p. 45) and Teed (2003, p. 29) indicate that La Graciosa thistle has only a minimally persistent seed bank. (USFWS, 2018). We presume that La Graciosa thistle reproduces sexually; potential pollinators include ants, beetles, bees, flies, and butterflies (Service 2020, p. 7). Many wetland-adapted (hydrophytic or aquatic) plant species persist in the soil as a seedbank (DeBerry and Perry 2000, p. 4), and La Graciosa thistle appears to have at least a minimally persistent seedbank (Service 2020, pp. 8–9 and 59). Seed dispersal is by wind and likely also by water. (USFWS, 2024)

**Reproduction Narrative**

Adult: Cirsium scariosum var. loncholepis (La Graciosa thistle) is a short-lived monocarpic perennial (a plant that blooms once, then dies) (Hendrickson 1990, Keil and Turner 1993, Teed 2003). C. loncholepis flowers bloom between June to August (NatureServe, 2015). Large individuals produce more flowering heads and more seeds per head (average = 473 seeds per plant) than smaller individuals (average = 168 seeds per plant), and therefore contribute disproportionately to the future seedbank of the population (M. Lea, California Polytechnic State University, San Luis Obispo, pers. comm. 2001).

**Habitat Type**

Adult: Wetlands (USFWS, 2011)

**Habitat Vegetation or Surface Water Classification**

Adult: Mesic wetlands, coastal dunes, brackish marshes and swamps (USFWS, 2011; NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Intermediate moisture (USFWS, 2011)

**Geographic or Habitat Restraints or Barriers**

Adult: Requires medium moisture conditions that are neither very wet nor very dry (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: La Graciosa thistle exists as groups of individuals in wetland habitats in an arid and semi-arid landscape. The plants inhabit the margins of wetlands (swales, lakes, ponds, freshwater marshes, streams, rivers, seeps) in southwestern San Luis Obispo County and western Santa Barbara County in central coastal California. The majority of occurrences are associated with wetlands in the backdunes of two coastal sand dune complexes, the Callender Dunes and the Guadalupe Dunes (Figure 1). Many of the wetlands in the sand dune complexes occur where the groundwater table is at or near the surface (Lea 2002, p. 66; California Department of Fish and Game 2005, p. 328), and the water levels rise and fall naturally with rainfall. Low water levels can be exacerbated by drought (Holland et al. 1995, p. 23). (USFWS, 2018)

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (USFWS, 2011)

**Dispersal**

Adult: High (USFWS, 2011)

**Dispersal/Migration Narrative**

Adult: The achenes (fruit) are 0.01 to 0.02 inches (3 to 4 mm) long and topped by an umbrella of long awns (0.6 to 1.0 in) that are ideal for wind dispersal (Keil and Turner 1993). Research has shown that Cirsium scariosum var. loncholepis are long-distance dispersers. (USFWS, 2011)

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2018)

**Species Trends:**

Declining (USFWS, 2018)

**Resiliency:**

In summary, of the 21 known occurrences of La Graciosa thistle, 16 are likely extirpated, four are extant, and one has unknown status. Three of the four extant occurrences have moderate resiliency, suggesting a moderate ability of these three remaining occurrences to withstand stochastic events and natural environmental variation. One of the four extant occurrences has low resiliency, indicating a reduced ability to withstand stochastic events and natural environmental variation. Of the four extant occurrences, one is protected on a National Wildlife Refuge, one is protected on private property by a conservation easement, one is currently protected on private property by a biological opinion, and one is on two private properties with current protection on one by a biological opinion (USFWS, 2018).

**Representation:**

In summary, the results indicate that the genetic diversity and the spatial extent of La Graciosa thistle have declined substantially from historical conditions. Gene flow among the four extant occurrences appears limited, and it was likely much greater historically. The four extant occurrences are in the Sand Dune Complexes population. Representation in the other three populations appears to have been lost, suggesting the species has lost potential capability for adapting to changes (natural or human caused) in its environment (USFWS, 2018).

**Redundancy:**

In summary, with only four extant occurrences and 16 likely extirpated occurrences (and one occurrence with unknown status), the redundancy of La Graciosa thistle is severely reduced. This reduction decreases the ability of the species to withstand catastrophic events and to survive in the face of unpredictable and highly consequential events for which adaptation is unlikely (USFWS, 2018).

**Number of Populations:**

8 extant occurrences; 15 likely extirpated occurrences (USFWS, 2024)

**Additional Population-level Information:**

There are currently 23 La Graciosa thistle EOs (CNDDB 2024b, website); two of these EOs (36 and 37) are new and one EO (16) has changed from extirpated to extant. We now consider eight EOs extant, including portions of EO 6, and EO 11, EO 12, EO 16, EO 18, EO 31, EO 32, and EO 36. We consider 14 EOs likely extirpated, including EO 1, EO 2, EO 3, EO 4, EO 8, EO 10, EO 13, EO 14, EO 19, EO 20, EO 28, EO 30, EO 34, and EO 37. The status of EO 33 remains unknown because it is privately owned, and we have not been able to access it for surveys. At the time of listing, we noted that the dune La Graciosa populations were small, isolated, and showed reduced reproductive vigor (Service 2000, p. 14889). We stated that 7 of the known populations were reported to have fewer than 60 individuals each. We also said that the Santa Maria River population had a substantial number of plants, but fluctuated between 6,000 and 54,000 individuals, and that this population experienced a significant disruption due to a flooding event that occurred in 1998 (USFWS, 2024).

**Population Narrative:**

Currently, 21 extirpated and extant occurrences range coastally from Pismo State Beach (occurrence 14; 35.107367, -120.625009), San Luis Obispo County, southward to the floodplain of the Santa Ynez River near the south entrance of Vandenberg Air Force Base (occurrence 1;

34.662962, -120.556957), Santa Barbara County (32.7 km/20.3 mi distance), and from the Pacific Ocean eastward to a freshwater marsh 1.6 km/1.0 mi northeast of Los Alamos (occurrence 33; 34.748658, -120.259412), Santa Barbara County (31.7 km/19.7 mi distance). The occurrence previously reported in Monterey County has since been determined to be the Alameda County thistle (Cirsium quercetorum) (Lea 2002, p. 3). The majority (n = 17) of occurrences are within 6.3 km/3.9 mi of the coast, while four occurrences are at substantially greater distances. Most of the occurrences (n = 16) are in or proximal to two coastal sand dune complexes in San Luis Obispo County: the Callender Dunes just south of Arroyo Grande, and the contiguous Guadalupe Dunes just north of the Santa Maria River Of the 21 known occurrences, 16 are likely extirpated, four are currently extant (occurrences 6, 11, 18, 31), and one has unknown status. The four extant occurrences are on lands of various ownership: one occurrence on private property of Chevron Corporation (18), one occurrence on private properties of Chevron Corporation and another landowner (6), one occurrence on private property with a conservation easement to the Land Conservancy of San Luis Obispo County (11), and one occurrence on Guadalupe-Nipomo Dunes National Wildlife Refuge (31). (USFWS, 2018)

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat to La Graciosa thistle in 2018 is lack of water, with groundwater decline as the likely major source. The groundwater decline appears to be a result of extraction for urban, agricultural and industrial uses, and it is exacerbated by drought and climate change. Groundwater decline causes habitat loss and degradation for La Graciosa thistle. Past development and agriculture have also caused substantial habitat loss and fragmentation by conversion of land for other uses (Hendrickson 1990b, p. 22). From the 1850's to 1987, 90% of California's coastal wetlands disappeared (Caughman and Ginsberg 1987, p. 24). In the 21st century, the remaining wetlands in central coastal California continue to decrease in quantity and quality (USFWS 2011, p. 11). Due to its minimally persistent seed bank, any occurrence of the species that has not had flowering plants over several consecutive years is at risk of extirpation. (USFWS, 2018)

**Stressor:** Urbanization (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Most of the historical occurrences and their surrounding areas are urbanized and/or indirectly impacted by urbanization (Service 2009a, CNDDB 2010). As mentioned above in the Abundance and Population Trends section, Cirsium scariosum var. loncholepis has experienced considerable declines throughout its range in the number of populations, occurrences, and individuals. It is only known to be extant at 8 of the 21 known occurrences (see Table 1). This decline in range, populations, occurrences, and individuals has further limited this species' ability to colonize or recolonize adjacent and intermediate locations of suitable habitat. (USFWS, 2011)

**Stressor:** Development of habitat for petroleum extraction (USFWS, 2011)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Habitat loss has been implicated from petroleum related activities. (USFWS, 2011)

**Stressor:** Cattle grazing and herbivory (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cattle have been documented crushing and breaking C. scariosum var. loncholepis plants on the Guadalupe-Nipomo National Wildlife Refuge (Elvin 2007d). Trampling and crushing impacts from cattle have been documented in and among plants at the Chevron project site in the Guadalupe Dunes (Elvin 2006). Cirsium scariosum var. loncholepis was last reported at the Cañada de Las Flores population in 1989 (Service 2009a). This population has been overgrazed according one local rancher (Elvin 2007c). This overgrazing has reduced plant cover, compacted the soil, and may have crushed plants at this population. Trampling and crushing of plants and compaction of soil may have been an exacerbating circumstance that led to the possible extirpation of this species at this population. While this plant may be able to withstand some herbivory, it may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. (USFWS, 2011)

**Stressor:** Loss of connectivity between populations (Long-Distance Dispersal) (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recent research on species that are long-distance dispersers (such as Cirsium scariosum var. loncholepis) determined that when the distances between suitable habitat sites for a species become greater than its dispersal distance (such as due to habitat fragmentation), its long-term survival will be threatened unless the long-distance dispersal between the sites can be re-established (Trakhtenbrot et al. 2005). Alterations of hydrological regimes (e.g., flood control) have increased the lack of connectivity between populations (Service 2009a). Wilken (2009a) stated that the current hydrological regulatory process in the Santa Ynez River may not be conducive to conditions favoring establishment of C. scariosum var. loncholepis. Connectivity between populations, particularly natural riparian drainages in Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River that are not channelized or confined by barriers or dams, such that they have soft bottoms and sides and a natural flood plain (allowing uninterrupted water flows) is one of the primary constituent elements for C. scariosum var. loncholepis in the final critical habitat rule (Service 2009a) and is important to maintain connectivity between populations for see dispersal and the establishment of intermediate linkage populations that may be transitory in nature. Habitat that would provide connectivity between occurrences and populations is essential to recover C. scariosum var. loncholepis (Service 2009a). (USFWS, 2011)

**Stressor:** Water quality (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats identified since the time of listing discussed above under Factor A include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or

historically supported Cirsium scariosum var. loncholepis. These nutrient levels have a direct effect on the vegetation in these watersheds, which causes excessive growth that is consistent with biostimulation and eutrophication. Excessive nutrient inputs can lead to vegetation community composition changes due to biostimulatory effects (California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et al. 1998). (USFWS, 2011)

**Stressor:** Genetics as affected by small population size (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The limited gene pool of this species may depress its reproductive vigor. Human-caused or natural environmental disturbances (e.g., flood, drought, disease) could increase the risk of extinction of Cirsium scariosum var. loncholepis. Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991); this has already been observed in C. scariosum var. loncholepis (Hendrickson 1990). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). Low levels of genetic variation among and within populations could impair a species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor) (Arias et al. no date). The existence of less than 10 populations and the small number of individuals in these populations places Cirsium scariosum var. loncholepis at extreme risk of extinction due to low levels of genetic diversity. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The extent to which climate change could affect C. scariosum var. loncholepis is unknown at this time due to the general nature of these predictions. Despite the uncertainty regarding the specific effects of climate change on this species, an increase in the rate of sea level rise has been predicted for the coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). In particular, dunes along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat estimated to be between 459 and 1,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because Cirsium scariosum var. loncholepis occurs in coastal dune habitats, erosion of these areas and corresponding loss or decreased quality of habitat could potentially adversely affect the species. (USFWS, 2011)

**Stressor:** Flood Control Management and Maintenance Activities (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Flood Control Management and Maintenance Activities. Historical winter storm events in 2023 caused substantial sedimentation, debris deposits, and flooding, with multiple channel breaches and extensive inundation in the City of Guadalupe, Santa Barbara County. From 2023 to 2024, the Santa Barbara County Flood Control District (SBCFCD) completed an emergency sedimentation removal, flood control, and maintenance project within the Santa Maria River channel, surrounding riparian corridor and floodplain, and immediately adjacent areas. The project area extended from approximately the intersection of the river with the overpass bridge along State Highway Route 1, to the Pacific Ocean, totaling approximately eight km (five mi) in length. SBCFCD removed excavated sediment and debris across approximately 150 acres of the project area and constructed an earthen berm along the southern side of the riverbank to serve as a barrier directing flows back into the river channel (U.S. Army Corps of Engineers, Los Angeles District 2023, entire) (USFWS, 2024).

***Recovery***

**Reclassification Criteria:**
La Graciosa thistle may be considered for downlisting when the following criteria are met: 1) At least nine occurrences exist, with a minimum of two occurrences from each of two different population units, and they display stable or increasing trends over 10 consecutive years.1 2) Each of the nine occurrences is being consistently managed in a way that will support the continued existence of La Graciosa thistle and its habitat, including seed banking, propagation and outplanting efforts, invasive weed abatement, and assurances for adequate hydrology within associated aquatic features. 3) Annual monitoring and reporting demonstrate that management is effective over 10 consecutive years. 4) An ex situ conservation seed bank is established and maintained at one or more facilities certified by the Center for Plant Conservation. (USFWS, 2021)

Recovery Priority Number: 2

**Delisting Criteria:**
Once the downlisting criteria have been met, La Graciosa thistle may be considered for delisting when the following criteria are met: 1) At least 13 occurrences exist, with a minimum of two occurrences from each of three different population units and they display stable or increasing trends over 10 consecutive years. 2 2) Each of the 13 occurrences is secure from known, plausible threats including from groundwater decline. 3) Each of the 13 occurrences is being consistently managed in a way that will support the continued existence of La Graciosa thistle and its habitat, including seed banking, propagation and outplanting efforts, invasive weed abatement, and assurances for adequate hydrology within associated aquatic features. 4) Annual monitoring and reporting demonstrate that management is effective over 10 consecutive years. (USFWS, 2021)

**Recovery Actions:**

- Recommendation for Future Actions from the 2019 5-Year Review: The results of our 2018 SSA indicate that La Graciosa thistle viability has declined sharply from historic conditions and has continued to decline since the 2011 5-year review. Both near-tenn and long-term efforts are required to achieve recovery. Several recommendations designed to halt this downward trajectory and ultimately reverse it, so that La Graciosa thistle can recover and persist into the future, are provided below. (USFWS, 2018)

- Near-term Recovery Actions: • Annual monitoring at the five extant occurrences; • Collect seed for banking and bulking, test seed viability; 10 • Conduct outplanting of La Graciosa thistle at historical occurrences and in other potentially suitable habitats; • Conduct habitat restoration and management at five extant occurrences and any newly established sites (including but not limited to- invasive species management, manual disturbance such as removal of thatch and vegetation clearing, supplemental watering, removal of overgrown hydrophytic species, re-introduction of controlled grazing regimes as a potential invasive species management tool, and installation of cages around individual plants during particular phenological stages); • Conduct education and outreach; and • Utilize the La Graciosa thistle Recovery Team and other potential recovery partners and stakeholders to facilitate ongoing collaborations. (USFWS, 2018)
- Longer-term Recovery Actions: • Establish living La Graciosa thistle collections at botanic gardens; • Pursue site access to occurrences (both historic and unknown) and potentially suitable habitats on private properties for surveys; and • Establish easements to support La Graciosa thistle recovery endeavors. (USFWS, 2018)
- Research Needs: • Habitat suitability modeling to identify potential outplanting sites throughout the species range; • Evaluation of the role of disturbance and management techniques for species recovery; • Seed viability and germination testing; • Hydrology and groundwater analyses; • Genetics work; • Pollination studies; and • Regional climate change simulations and projections. (USFWS, 2019)
- Near-Term Recovery Actions The aim of the near-term recovery actions is to prevent extirpation of the species at the eight extant occurrences, all of which are in the Sand Dunes Complex Population Unit. The actions include: 1) Habitat Restoration – invasive weed treatments with herbicides, abatement and removal to prevent re-infestations; woody debris removal to clear out downed trees and tree limbs; possibly thinning and trimming excessive arroyo willow (Salix lasiolepis), poison oak (Toxicodendron diversilobum) and blackberry (Rubus spp.); and management of dense thatch. Habitat restoration may also require dredging of aquatic features and other remedial measures to augment and renovate local hydrologic regimes. 2) Supplemental Watering – when necessary during drought or lack of water, specifically to ensure survival of particular individual plants and/or colonies. 3) Installation of Exclusionary Fencing and/or Cages – around individuals and colonies of La Graciosa thistle to prevent herbivory from mammals such as deer (Odocoileus hemionus) and rabbit (Sylvilagus audubonii), and trampling from wild pig (Sus scrofa). Fencing may also be used for disturbance studies associated with seasonal cattle grazing. 4) Propagation and Outplanting – coordinated and directed efforts to collect seed when and if it is readily available to produce seedlings from tracked maternal lines, which will be outplanted at locations that are extirpated, that have extremely low numbers of individuals and could become extirpated, or at appropriate sites located within close proximity to the extant occurrences. 5) Annual Monitoring and Reporting – these efforts are required to assess the effectiveness of the near-term actions, track and census the numbers of individuals at each occurrence and to both guide and determine future recovery actions. The property owners/managers of each extant occurrence have agreed to complete five consecutive years of annual monitoring with reporting and to participating in the near-term La Graciosa thistle recovery program. Longer-Term Recovery Actions The longer-term recovery actions are intended to inform the strategic future development of the species recovery program, fill important knowledge gaps and to systematically move the species towards downlisting and eventual delisting. These actions can occur within any and all of the population units, include future research needs, and consist of the following: 1) Establish and Maintain a

Conservation Seed Bank – seed will be collected from all extant occurrences and deposited into a permanent conservation collection at a facility that is certified by the Center for Plant Conservation. Certified affiliates are part of a national network that follow stringent guidelines for seed conservation banking set by the International Board for Plant Genetic Resources and in consultation with the National Laboratory for Genetic Resource Preservation. Once deposited, seed will be stored and curated in perpetuity to serve as emergency back-up if the species becomes extinct in the wild and for other recovery purposes. 2) Seed Viability Studies and Bulking – once the conservation seed bank is established, research will be conducted to evaluate the viability of La Graciosa thistle seed and efforts to bulk the seed will be pursued. These activities are to ensure that abundant seed is readily available for subsequent outplanting projects and recovery efforts. 3) Re-establish Several Extirpated Occurrences – facilitate outplanting efforts at numerous sites that are likely to have cooperative recovery partners based on the current land ownership status and land use practices and/or that conducive conservation easements are already established. These priority sites include and are presented in numeric order: • Occurrence 1 at Vandenberg Air Force Base; Vandenberg South Population Unit, would re-establish the species in the southwestern part of the geographic range. • Occurrence 13 at Oso Flaco Lake in Oceano Dunes State Vehicular Recreation Area; Sand Dune Complex Population Unit; owned by California Department of Parks and Recreation. • Occurrence 14 at Pismo State Beach; Sand Dune Complex Population Unit; owned by California Department of Parks and Recreation. This site also has the Oceano Dunes District Visitor Center, which could provide an opportunity to promote public education/outreach for La Graciosa thistle. • Occurrence 16 at Black Lake Ecological Area; Sand Dune Complex Population Unit; owned by Land Conservancy of San Luis Obispo County. 4) Establish cooperative relationships with other landowners – engage potential partners with the goal of surveying parcels not previously surveyed for additional occurrences or suitable habitat that could be used for additional outplanting efforts. 5) Fulfill Research Needs – work with partners to fund research and other collaborative studies to fill knowledge gaps about the species including (but not limited to) the following: best management practices and methods for the various life stages of the species; species response to disturbance from grazing, thatch removal and other vegetation management techniques; demographic studies, pollination ecology research, genetics research, habitat suitability analyses and modeling, groundwater testing and mapping and other hydrologic modeling for evaluating variable climate change scenarios. (USFWS, 2021)

***Conservation Measures and Best Management Practices:***

- Conservation Measures for La Graciosa Thistle: In 2018, conservation measures are being implemented on two properties: the private property of Chevron Corporation, and Oceano Dunes State Vehicular Recreation Area (1,457 ha/3,600 ac). Since 2005, Chevron Corporation has managed occurrences 6, 18 and 32 (Table 6) in the Guadalupe Oil Field under a biological opinion (USFWS 2005, entire) issued under the U.S. Endangered Species Act. Specifically, their actions have included the following: • annual monitoring of three occurrences of La Graciosa thistle on their property (a fourth occurrence was identified in 2018); • salvaging and transplanting 1,629 individuals that would have been impacted by remediation and restoration activities, of which 1,136 individuals survived; • outplanting 2,842 individuals (2,826 grown from seed), of which 1,893 individuals flowered; • managing invasive plants in the Guadalupe Oil Field; and • removing feral pigs.
- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Conduct comprehensive annual surveys of abundance, assess the overall status of the species, and evaluate current threats at each of the eight

extant EOs. Include estimates of the total number of La Graciosa thistle individuals present at each location, using uniform methodologies suitable for trend analyses, and map the total occupied area. Collect other pertinent ecological and demographic data including co-occurring and co-dominant species, hydrologic regimes, presence and abundance of nonnative, invasive species, timing of phenology, effective population size, and continue observations of any potential insect pollinators, and seed and foliage herbivory. 2. Conduct experimental research to determine the most effective management techniques for occupied La Graciosa thistle sites to ensure persistence and expansion of the species. We recommend evaluating the use of grazing and other disturbance techniques designed to manage nonnative, invasive weeds and overgrown hydrophytic and other woody riparian vegetation. 3. Obtain conservation easements or acquire other sites within the species current range to introduce the species to new locations or repatriate it at extirpated sites. Include long-term management strategies to ensure success and persistence of the species. 4. Continue making conservation seedbank accessions of La Graciosa thistle seed for banking every three to five years and prioritize those EOs that do not yet have accessions. Conduct seed bulking activities to ensure an ample supply of seed for recovery efforts and for insurance in the event of stochastic loss or extirpation (USFWS, 2024).

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# SPECIES ACCOUNT: *Cirsium pitcheri* (Pitcher's thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 8/17/1988; Great Lakes-Big Rivers Region (R3)

**Physical Description**

Pitcher's thistle is a monocarpic (flowers and sets seed only once), perennial, herbaceous plant, generally flowering after a 5-8 year juvenile stage (Loveless 1984). The stems and leaves of juveniles and adults are woolly-white, and the leaves are deeply pinnatifid with the lobes less than 1 centimeter (cm) wide and up to 4 cm long. Minute spines are concentrated along the edge of the leaf at its base, with a few spines between the lobes of the distal leaf margins. The flowering stems are up to 1 meter (m) tall and have several to a dozen widely scattered leaves. Individuals typically have a single branching flowering stem with terminal and axillary flowering heads of a cream or pinkish color. Juveniles and adults have a taproot that may reach 2 m in length (McEachern and Pavlovic pers. obs.). (USFWS, 2002)

**Taxonomy**

This distinctive dune plant, often referred to as the dune thistle, was first noted by Dr. Zina Pitcher about 1827 at the Grand Sable Dunes of the Upper Peninsula of Michigan. The species was first described by Eaton (1829) as Cnicus pitcheri from the type specimen which was apparently collected in 1827 on or near Mackinac Island by Dr. Edwin James (Voss 1996). (USFWS, 2002)

**Historical Range**

Pitcher's thistle (Cirsium pitcheri) is endemic to the beaches and grassland dunes of Lakes Michigan, Superior, and Huron. Distribution of the species extends along the Lake Michigan shoreline in Wisconsin. In the east it ranges through northern Lake Huron to the Manitoulin Island archipelago and southern Georgian Bay in Ontario. Pitcher's thistle extends as far south as Lambton County, Ontario, Canada on Lake Huron, (USFWS, 2002)

**Current Range**

Current distribution is Illinois (Lake County), Indiana (Porter County), and Michigan (Alcona, Alger, Allegan, Alpena, Antrim, Arenac, Benzie, Berrien, Charlevoix, Cheboygan, Chippewa, Delta, Emmet, Grand Traverse, Huron, Iosco, Leelanau, Mackinac, Manistee, Mason, Muskegon, Oceana, Ottawa, Presque Isle, Schoolcraft, Van Buren Counties), and Wisconsin (Door, Manitowoc, and Sheboygan Counties). (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual

**Other Reproductive Information**

Adult: Pitcher's thistle reproduces only sexually. Pollination occurs through a variety of insects but primarily through bees (Hymenoptera). Pitcher's thistle blooms from June to September and is protandrous (pollen maturing before stigmas are receptive on individual flowers), and partially self-compatible (Higman and Penskar 1999). Seed dispersal occurs from June to August (McEachern 1992), depending on latitude, and does so through individual seeds blowing from the inflorescence head or by the whole plant and heads falling to the ground at the end of the growing season. A secondary means of dispersal is by wind blowing seed and seed heads across the sand, snow or water surface (Loveless 1984). The seeds are subject to herbivory by artichoke plume moth larvae (Platyptilia carduidactyla), ground squirrels, birds, especially goldfinches (Spinus tristis), and deer. Seed dormancy is broken by cold, moist stratification (Hamzé and Jolls 2000), with seed germination occurring in May and June (Loveless 1984). After germination, seedlings emerge producing one to six leaves in the first season (Loveless 1984). Seedling densities are greater where bare ground is abundant (McEachern et al. 1989) than in stabilized sites with greater vegetation cover. Juvenile plants typically consist of one rosette and may remain dormant for one or two years as a result of drought (McEachern 1992). The chances of juvenile mortality decrease as the plants increase in size. Causes of mortality include trampling (Keddy and Keddy 1984; Gibson 1988), sand deposition and erosion, drought, and herbivory. Juveniles grow or maintain a constant size throughout the growing season, but may diminish in size over the winter (Loveless 1984; McEachern 1992). Observations indicate juvenile plants in foredunes grow by increasing leaf number, whereas in inland stabilized habitats they grow by increasing leaf size (Loveless 1984). These growth differences may be significant in determining the age when juveniles reach a critical flowering size. The probability of insect herbivory increased with juvenile size, large juvenile density, and population successional stage (Stanforth et al. 1997). However, Rowland and Maun (2001) found that plants negatively affected by herbivory were able to recover and compensate for lost tissue by the following growing season. Conversely, plants subjected to herbivory, required a longer juvenile period to reach reproductive stage, thus increasing the period of vulnerability to herbivory and environmental stresses. Pitcher's thistle typically reaches reproductive age after 5 to 8 years. Reproduction appears to be correlated with habitat as Loveless (1984) found that adults bloom sooner in more stabilized habitats than in foredunes. Specific reproductive triggers are unknown, but the length of the longest leaf (Loveless 1984) and the root crown diameter (McEachern 1992) were found to be significant predictors of timing of reproduction. However, flowering probably involves an interaction between plant size (growth rate) and age, as small plants have also been observed to flower (USFWS 2002). Pitcher's thistle plants exhibit overcompensation as a response to damage (i.e., herbivory) by producing multi-stemmed plants. Multi-stemmed plants produce more seeds per plant and exhibit higher pollination activity than single-stemmed plants (Dao 2013). (USFWS, 2018)

**Reproduction Narrative**

Adult: Cirsium pitcheri is closely related to C. canescens, a thistle of the sand hills of the Great Plains (Ownbey and Hsi 1963). Recent electrophoretic evidence has shown that the thistles share the same genetic loci, but differ greatly in the level of genetic diversity (Loveless and Hamrick 1988). Cirsium pitcheri possesses a much reduced level of genetic variability than does C. canescens, suggesting derivative-progenitor relationship, respectively. It is believed that Pitcher's thistle migrated to the Great Lakes region soon after the close of the Wisconsinan glaciation and that its reduced genetic diversity is a result of repeated and prolonged population bottlenecks (Loveless and Hamrick 1988).Seed germination in C. pitcheri has been observed during June in Ontario (Keddy and Keddy 1984, Keddy 1981), Michigan and Indiana (McEachern et al. 1989). Keddy and Keddy (1984) found that the highest seedling mortality typically occurred in sand substrates, with the lowest in substrate of debris. In a season of drought, Ziemer (pers. comm.) still found seedling survivorship in the species to be fairly high (roughly 40%). Seedling survivorship in her study was found to be highest of the lakeward side of the foredune where active sand deposition and associated grasses (Ammophila and Calamovilfa) were common. Although Keddy and Keddy (1984) found that mortality did not significantly differ between seedlings growing in clusters or individually, Ziemer (pers. comm.) arrived at different conclusions. In her study, seedling survivorship was found to be highest in areas where other seedlings occurred.Once established in the rosette form, mortality is low (Keddy and Keddy 1984). This is, in part, due to the fact that immature plants can withstand burial by up to 15 cm of sand (Weller in litt.) and possess taproots that often reach down 5 to 7 feet, to where available moisture lies (Pepoon 1927). Of 193 rosettes studied in Ontario by Keddy and Keddy (1984), only seven died (due in part to caribou trampling and human intervention). Plume moth (Platyptilia carduidactyla) larvae occur within the centers of rosettes but do not appear to cause mortality (Keddy and Keddy 1984). They can, however, cause injury to the apical meristem of the plant, resulting in a multi-branched parental plant.Cirsium pitcheri is a monocarpic species which exists in a rosette for 5-8 years, flowers the following year, then dies (Crispin and Penskar 1990, McEachern et al. 1989, Dobberpuhl and Gibson 1987). Plants can remain in the rosette form until enough resources have been obtained in the root system to fuel the bolting plant and subsequent seed production (Keddy and Keddy 1984). The proportion of juvenile to adult plants is not unexpectedly skewed in favor of juvenile plants, 71.8% : 28.2% in Door County and 69.8% : 31.2% in Manitowoc County, Wisconsin (Dobberpuhl and Gibson 1987).According to Keddy and Keddy (1984) in Ontario, plants in grassland habitat dominated by beach grass and horsetail produced over twice as many branches and flower heads than plants in the debris habitat or on a crescent beach. Those on the crescent beach were nearly all vertical. This branched growth form may be attributed to the abundance of plume moth (Platyptilia carduidactyla) larvae in the grass habitat (Keddy and Keddy 1984). Attacks, by these larvae typically result in multi-branched individuals, as discussed above.Growth of C. pitcheri plants is also hindered at times by spittlebugs which lay eggs in the meristems of the plants, damaging newly-forming leaves (Crispin and Penskar 1990). This apparently causes mortality in some plants.Flowering begins in late June, peaks in late July, then declines rapidly (McEachern et al. 1989, Loveless 1983). According to Loveless (1983), many plants are dead and dying by early August, but some continue flowering until mid-September. After four to seven days of blooming, flowers begin to wither and die (Keddy 1981). As flowers brown, the involucral bracts gradually close in around them, protecting developing seeds. Flower heads per stalk vary from two to as many as 125 (Keddy 1981).Flower tubes of C. pitcheri contain several micro-liters of sweet-scented nectar secreted by a ridge at the base of the style (Keddy 1981, Knuth 1908). Apparently, a wide array of potential pollinators are attracted to this nectar. Of the 10 species of insects listed as flower visitors in Ontario (Keddy and Keddy 1984) and 23 insect visitors observed by Loveless (1983) in Michigan, only one species was the same, a bumblebee (Bombus perplexus). Insect pollen vectors include species within the genus Bombus (bumble-bees), Megachile (megachilid bees), Melissodes (anthophorid bees), Lasioglossum (small halictid bees), Agapostemon (large halictid bees), and butterflies and skippers of several genera (Loveless 1983). Other visitors to the flowers include flies, wasps, honeybees and sedentary beetles and bugs (Loveless 1983). Keddy and Keddy (1984) listed lepidopterans, dipterans and hymenopterans as flower visitors in Ontario, the most abundant of which was Bombus vagans. Prominent butterfly pollinators included Vanessa cardui and Daneus peleyippus (Crispin and Penskar 1990). Nocturnal visitors have not been studied, but moths are believed to visit the flowers (Loveless 1983). For a species list of known pollen vectors and flower visitors, see Loveless (1983) and Keddy and Keddy (1984).Seed set is known to decline between late July and August in C. pitcheri. This decline in seed set has been attributed, in part, to pollinator availability which parallels this decline (Loveless 1983). Loveless (1983) observed that many plants died prior to maturing a single flower head, suggesting that the species allocates its resources early in the season when the likelihood of maturing fruits is highest.The artichoke plume moth (Platyptilia carduidactyla) larvae feed on the immature seeds of C. pitcheri, sometimes causing flower mortality (McEachern et al. 1989, Keddy and Keddy 1984). This insect has been observed by Loveless (1983) in Michigan, Keddy and Keddy (1984) in Ontario, and Dobberpuhl and Gibson (1987) in Wisconsin. In Ontario, Keddy and Keddy (1984) found that most plants were affected by the moth only in July, with predation highest in a grass habitat. Fewer plants were infected in a habitat of debris, while predation was non-existent in a crescent beach population. Loveless (1983), however, found that levels of seed damage in various habitats were nearly equal, suggesting that seed predation was density-dependant. In addition, Loveless observed that seed predation in Michigan did not markedly change throughout the season. For a brief description of the plume moth life cycle, see Keddy (1981). McEachern (pers. comm.) stated that she had observed a larva within the flower head in Michigan but is unsure as to its identity at this time.Mosquin et al. (1986) suggested that the presence of the plume moth in C. pitcheri populations may be mutually beneficial. Presence of larvae in the rosettes of C. pitcheri causes the plant to become multi-branched (Keddy and Keddy 1984). As a consequence, more flowers and seeds are produced. At present, there is little information to substantiate this hypothesis. In addition, the moth is also known to feed on the seeds of the thistle, so there may be a simple trade off or net loss of seed production despite the multiple-branched stemming of the plant. Keddy and Keddy (1984), in fact, suggested that up to 40% of the normal seed crop was lost in a given year in Ontario as a result of the moth predation.American goldfinches were observed to devour approximately 50% of the seeds within a given flowerhead (Loveless 1984). Other birds, primarily sparrows, forage on unburied seeds. The thirteen-lined ground squirrel (Spermophilus tridecemlineatus) is ;   (NatureServe, 2015)

**Habitat Type**

Adult: Great Lakes sand dunes

**Environmental Specificity**

Adult: Broad (USFWS, 2016)

**Habitat Narrative**

Adult: Cirsium pitcheri occurs most prominently in Michigan, occurring in 18 counties along the shorelines of Lakes Michigan, Huron and Superior (Nepstad 1981). In Wisconsin, the species currently exists in eight sites in four counties on the Lake Superior shoreline (Alverson 1981). The species occurs at seven extant sites along Lake Michigan in Indiana (IN NHP 1989), but has been extirpated from Illinois (Sidle 1987, White 1981). It is also known from roughly 12 extant sites in Ontario, including a population on the shoreline of Lake Superior (Keddy and Keddy 1984, Keddy 1988).Pitcher's thistle is a regional endemic restricted to the dune habitats in the western Great Lakes region (USFWS 1987, Dobberpuhl and Gibson 1987, Keddy and Keddy 1984, Loveless 1983, Guire and Voss 1963). The species is a colonizer on open dune ridges, dune blowouts, and along disturbed sites in sand dunes, but is found on stabilized grassy sand terraces, sandy gravel flats and dune valleys as well (Loveless 1983). In all habitat types, however, the species appears to establish itself only in very open, sandy soil (Loveless 1983).McEachern et al. (1989) described the habitats associated with the lakeshores as: 1) extremely exposed open communities on lake level foredunes and dune bluff edges dominated by Ammophila breviligulata, 2) transitional communities dominated by three dune grasses, A. breviligulata, Calamovilfa longifolia and Schizachyrium scoparium, and 3) stabilized inland blowouts characterized by S. scoparium/C. longifolia codominance and moderate vegetation and litter accumulation. These three habitat types mark a successional gradient, in which A. breviligulata, adapted to high rates of sand deposition occurring in the shoreline habitats, is replaced by the more competitive C. longifolia and finally, S. scoparium in progressively stable inland areas (McEachern et al. 1989). Associated with this change in dominant vegetation along a shoreline to inland transect, there is an equally significant reduction in the percentage of bare ground. This amount of bare ground is apparently significant, for it is in the most stable, S. scoparium dominated areas that C. pitcheri is the least abundant (McEachern et al. 1989).In Michigan, C. pitcheri is most common along the northern and northeastern shore of Lake Michigan, although small populations are known from the southeastern shores of Lake Michigan and northern Lake Huron (Crispin and Penskar 1990). A few populations also occur along Lake Superior. Cirsium pitcheri typically grows in association with Ammophila breviligulata, Schizachyrium scoparium, Arabis lyrata, Arctostaphylos uva-ursi, Calamovilfa longifolia and Agropyron dasystachyum (Crispin and Penskar 1990, MI NFI 1990). At disturbed sites, Asclepias syriaca may be present (Crispin and Penskar 1990).At Sleeping Bear Dunes National Lakeshore in Michigan, the species is apparently doing well, even in the intensely utilized areas around the marina (Hazlett and van de Kopple 1983). A recent survey by McEachern et al. (1989) found that C. pitcheri was occupying much of its potential habitat: foredunes, blowouts, dune ridges, valleys and slopes. Although C. pitcheri was least common from the backslopes of inland dunes, localized populations were found there as well.On the Manitou Islands portion of Sleeping Bear Lakeshore, plants have been found on perched (260 feet above Lake Michigan, on glacial moraines) and coastal dunes. McEachern et al. (1989) found that plants growing on the dunes of South Manitou Island appeared more stunted and were more dispersed than those on the mainland, possibly reflecting the harsher environment of the island. Associates on a gravel lag behind a coastal dune complex at Dimmick's Point on North Manitou Island include Agropyron dasystachyum, Schizachyrium scoparium, Anemone multifida, Artemisia caudata, Betula papyrifera, Campanula rotundifolia, Carex garberi, Thuja occidentalis and Zygadenus glaucus with an overstory of Betula papyrifera. Associates in a dune blowout on South Manitou include Schizachyrium scoparium, Anemone multifida, Arctostaphylos uva-ursi, Arenaria stricta, Aster sp., Calamovilfa longifolia, Coreopsis palmata, Equisetum hyemale, Ostrya virginiana, Polygonatum pubescens, Prunus virginiana, Trientalis borealis, Trillium grandiflorum, Viburnum acerifolium, Viola canadensis and Viola sp. (Hazlett and van de Kopple 1983). For additional habitat information pertinent to Sleeping Bear National Lakeshore, see McEachern et al. (1989), Hazlett (1986) and Loveless (1983).At Grand Sable Dunes within the Pictured Rocks National Lakeshore of Michigan, McEachern et al. (1989) found the populations occupying dune and blowout habitats ranging from the dune bluff inland to wooded areas. In contrast to Sleeping Bear, populations were scattered and were far less abundant. For habitat information concerning populations at Pictured Rocks National Lakeshore, see McEachern et al. (1989).Within the state of Indiana, plants have been observed on dunes, foredunes, blowouts and beaches along Lake Michigan (IN NHP 1989). At the Indiana Dunes National Lakeshore, Bowles et al. (1985) found Cirsium pitcheri restricted to early and mid-successional blowouts on the high dunes adjacent to Lake Michigan. It appeared to be absent from the first foredune. Sites were extremely well-drained and support sparse dry sand prairie-like communities (Bowles et al. 1985). A recent survey of the site by McEachern et al. (1989) produced similar conclusions. In all, six small populations were found, all on the steep, lakeward-facing slopes or grassland blowouts of the secondary dunes. No plants were observed on the beach and foredune complexes still rebuilding since the high-water levels of 1986 and 1987.Dobberpuhl and Gibson (1987) stated that in Wisconsin, the plant is found in three habitats: (1) dry sand of partially-stabilized dunes along Lake Michigan, (2) dry, open areas of loose sand (sand blowouts) behind the main foredune and infrequently on (3) low, moist to wet beaches. Colonies thrive best in situations where the dunes are somewhat stabilized, in various slope aspects and degrees of steepness. Two populations in Wisconsin are at the mouths of creeks, where continual sand deposition from the creeks provides new habitat and increasing site longevity (WI NHP 1990, Dobberpuhl and Gibson 1987). Associated plants species in Wisconsin include Agropyron dasystachyum, Calamovilfa longifolia var. magna, Elymus canadensis, Ammophila breviligulata, Agropyron trachycaulon, Artemisia caudata, Lathyrus maritimus, Oenothera parviflora, Potentilla anserina and Solidago gillmani (WI NHP 1990, Alverson 1979, Johnson and Iltis 1963).In Canada, C. pitcheri is found only in Ontario on sandy beaches and dunes of the shores of Lake Huron and Georgian Bay (Moore and Frankton 1974) and Lake Superior (Keddy and Keddy 1984, Keddy 1981). At Lake Superior sites in Pukaskwa National Park, plants grow approximately 1-2 meters above the lake level on gently sloping sand beaches in three distinct habitats: 1) grass (dominated by Ammophila breviligulata and Equisetum variegatum), 2) debris (dominated by Prunus pumila and Festuca saximontana) and 3) shrub (dominated by Juniperus horizontalis and Arctostaphylos uva-ursi) (Keddy and Keddy 1984, Keddy 1981). Most plants (79%) were found in the grass habitat, with 21% growing in the debris habitat. Less than 1% were found in the shrub habitat (NatureServe, 2015). The Pitcher's thistle (Cirsium pitcheri), also known as dune thistle, is a Great Lakes endemic that is typically found on open beaches and grassland dunes and occasionally on lag gravel associated with the shoreline dunes. The Service listed Pitcher's thistle as a threatened species under the Act on July 18, 1988 (USFWS 2002). Pitcher's thistle is one of a few plant species endemic to the post-Wisconsinan Great Lakes sand dunes. It is found most frequently in the near-shore plant communities where it colonizes patches of open, windblown areas of the landscape. The species gradually declines locally as the density of vegetation and ground litter increases through plant succession and in areas heavily used by people. Pitcher's thistle density peaks in mid-successional habitats and requires 70% open sand for successful seedling establishment and survival (McEachern 1992). Healthy populations of Pitcher's thistle are an indication of the general well-being of dune ecosystems. No species is known to depend completely on Pitcher's thistle. However, the rust, Puccinia laschii, that is sometimes found on adult Pitcher's thistle leaves may be host-specific, and therefore, dependent on it (Saville 1970). In addition, Pitcher's thistle is a food (pollen, nectar, and seed) source for many organisms (Keddy and Keddy 1984; Loveless 1984). Pitcher's thistle depends on the geomorphic processes that maintain dune systems to create sparsely vegetated habitats where successful population growth can occur. Populations are prone to extirpation due to successional change, erosional loss, and catastrophic events depending on their location. A shifting mosaic of dune processes on a large dune system landscape can ensure this species' persistence as long as seed is available to disperse to existing or newly created adjacent suitable habitats. For a particular occurrence of Pitcher's thistle to survive, disturbance must be frequent enough to prevent extirpation from succession and infrequent enough to allow juveniles to reach maturity; thus, the Pitcher's thistle life history is finely tuned to a specific disturbance regime (McEachern 1992). Disturbances may eliminate local occurrences, but as long as those disturbances are not synchronous throughout the landscape and occurrence creation exceeds decline, the species will persist (Pavlovic 1994).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal occurs from June to August (McEachern 1992), depending on latitude, and does so through individual seeds blowing from the inflorescence head or by the whole plant and heads falling to the ground at the end of the growing season. A secondary means of dispersal is by wind blowing seed and seed heads across the sand, snow or water surface (Loveless 1984). The seeds are subject to herbivory by artichoke plume moth larvae (Platyptilia carduidactyla), ground squirrels, birds, especially goldfinches (Spinus tristis), and deer.

***Population Information and Trends***

**Number of Populations:**

222 (USFWS, 2023)

**Population Size:**

> 1,000,000 in the U.S. (USFWS, 2023)

**Population Narrative:**

NatureServe (2023) notes there “are an estimated 50,000 plants in Canada, 10,000 to 20,000 in Wisconsin, 500-1000 in Indiana, and possibly over 1,000,000 individuals in Michigan (Slaughter and Cuthrell 2017)” and that over “the last 10 years this species has remained stable in Michigan, stable to slightly increased in Canada, declined >50% in Indiana, and stable to declined <25% in Wisconsin.” There is a total of 222 known occurrences of PITH in the United States (Figure 1). In Michigan, there are 182 extant occurrences, in Indiana there are 24 extant occurrences, in Illinois there are 5 known occurrences, and in Wisconsin there are 11 extant occurrences (personal comm. Pavlovic 2023). At the time of the previous 5-year review in 2018, several of the EOs that were found to be decreasing were located in southern Lower Michigan (Slaughter and Cuthrell 2017), and it was stated that inbreeding depression and other factors could leave EOs in southern Michigan prone to extirpation, resulting in fragmentation and isolation of remaining colony sites in other parts of the southern Great Lakes (Gauthier et al. 2010, Slaughter and Cuthrell 2017). There are 45 populations of PITH now known in Canada. Three populations at Pukaskwa National Park were surveyed annually between 1982 and 2015, and an additional 33 populations on Lake Huron were monitored annually between 2000 and 2017, with methods standardized in 2004 (Nantel et al. 2018). Monitoring at each location consisted in recording the total number of plants by life stage (i.e., seedling, rosette, or mature/flowering). Overall, habitat size increased from 2000 to 2010, stayed relatively constant until 2015, and has decreased since then (Nantel et al. 2018) (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pitcher’s thistle is threatened by habitat destruction, overuse, and repeated disturbance from trampling by beach and dune visitors and off-road vehicles. Approximately ten

percent of its population has been lost, modified or curtailed through these actions. Some populations have also been lost or negatively impacted through alteration of local dune geomorphic processes, which prevent the creation and maintenance of Pitcher's thistle habitat. In addition, shoreline stabilization projects, such as sea walls, rip rap, and planting of beach grass, northern white cedar, and some non-native species, also alter dune building processes and may decrease habitat available to Pitcher's thistle. (USFWS, 2016)

**Stressor:** Non-native and invasive species
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Encroachment by non-native and invasive species, such as spotted knapweed, baby's breath, and Lombardy poplar, also pose a threat to Pitcher's thistle. For example, spotted knapweed is known to negatively influence the soil in its vicinity to prevent the growth of native species (Louda et al. unpub. data 2007), as well as out-compete native species for resources. The introduction and spread of non-native insect species for biological control is an additional threat. Two species of non-native weevils used for biological control have been documented in Michigan, as well as some of the surrounding states, and these newly emerging threats place the range-wide existence of Pitcher's thistle at risk. These non-native weevils oviposit eggs near the base of developing seed heads (Louda et al. 1997, Louda et al. 2005, McEachern and Pavlovic 2013). Larvae develop inside the receptacle tissue at the base of the head, feeding on receptacle and eventually seeds within the ovary (Louda et al. 1997, Louda et al. 2005, McEachern and Pavlovic 2013). As the seed head matures, the weevils emerge as adults, often leaving visible exit holes at the base of the head (McEachern and Pavlovic 2013). The weevils' actions prevent seeds from forming or flowering. Flowerhead weevil (Rhinocyllus conicus) was introduced from Europe in 1969 to control Carduus species, especially musk thistles (Carduus nutans) and others plants (Rees 1982, Bradley 2007, Sauer and Bradley 2008). The weevil also develops on multiple native Cirsium species in the United States (Goeden and Ricker 1986a, 1986b, 1987a, 1987b; Turner et al. 1987; Louda et al. 1997). Laboratory and garden host specificity tests revealed that flowerhead weevils fed, oviposited, and developed completely on Pitcher's thistle, as well as its target species, and taller Pitcher's thistle plants with more flowerheads were significantly more vulnerable to the weevil (Louda et al. 2005). Rhinocyllus conicus has been documented in Wisconsin, where it was released in 1975, with a second release in 1978 (Sauer and Bradley 2008). It has since spread to several other counties (Sauer and Bradley 2008); however, it has not yet been documented in wild populations of Pitcher's thistle in the state. The weevil was also found on Pitcher's thistle in a common garden at Chicago Botanic Garden (CBG) in 2007 (J. Fant, CBG, pers. comm. 2007; N. Pavlovic, USGS, pers. comm., 2007) and in a Pitcher's thistle nursery at Illinois Beach State Park near a restoration site in 2011 (Bell and Hankins, unpublished, cited in McEachern and Pavlovic 2013). In 2012, R. conicus was collected from Pitcher's thistle at the Miller Dunes unit of the Indiana Dunes National Lakeshore (McEachern and Pavlovic 2013). Based on the 2012 surveys conducted in Michigan, the weevil was observed on musk thistles in Jackson and Lenawee counties (D. Landis, Michigan State University, pers. comm. 2012), which are not within range of Pitcher's thistle. A greenhouse test documented the weevil in approximately 40% of Pitcher's thistle seed heads and reduced seed set by 95% in those heads during the first year of infestation (Louda et al. 2005, Havens et al. 2012a). A demographic model suggests that R. conicus will reduce Pitcher's thistle population growth rate by 15% per year and the time to halve the population size from 66.9 years to 4.0–4.0 years (K. McEachern, USGS, pers. comm. 2011). In addition to reducing seed numbers in Pitcher's thistle, R. conicus predation is also

expected to reduce seed mass (M. Bowles, The Morton Arboretum, pers. comm. 2013). Larinus planus, a seed-eating weevil, was inadvertently introduced into the U.S. from Eurasia in the 1960s and has since been redistributed for control of Canada thistle (Cirsium arvense L.) (White 1972, Havens et al. 2012a, McEachern and Pavlovic 2013). In 2010, L. planus was first documented in Pitcher's thistle populations at Whitefish Dunes State Park, Door County, Wisconsin, in approximately one-third of examined seed heads (Havens et al. 2012). No viable seeds were found in those heads (Havens et al. 2012a). A more extensive survey of the Whitefish Dunes population in 2011 found the weevil in half the seed heads and almost no viable seeds (Havens et al. 2012a). Subsequent surveys of public and private lands throughout the Door Peninsula found L. planus in every Pitcher's thistle population (Havens et al. 2012a). In 2012, three Pitcher's thistle heads collected from research plots at Wilderness State Park, Emmet County, Michigan, had adult L. planus emerge from the flower heads in late-July 2012 (Havens et al. 2012b). Consequently, a more extensive search for the weevil was conducted at six element occurrences of Pitcher's thistle at Wilderness in mid-August 2012. Suspected weevil-damaged seed heads were collected and sent to CBG to examine for L. planus infestation. Although CBG found no adult weevils, most element occurrences had at least one damaged seed-head that was consistent with the weevil damage observed in Wisconsin, which consisted of one or more of the following characteristics: destruction of all or nearly all developing seeds, mass of digested ovules, seeds, frass remnants, and a pupal chamber visible in the receptacle tissue (Havens et al. 2012b). Currently, there is limited knowledge about the life-history of weevils, their relationships with Pitcher's thistle, and lack of knowledge of how to control the weevils along Great Lakes shoreline. (USFWS, 2016)

**Stressor:** Seed predation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pitcher's thistle seeds are subject to pre- and post- dispersal herbivory (USFWS 2002). American goldfinches (Spinus tristis) are one of the species listed in the recovery plan as being a pre-dispersal herbivore of Pitcher's thistle (USFWS 2002). The goldfinches have recently become more abundant at Indiana Dunes National Lakeshore (IDNL) and have been observed feeding on Pitcher's thistle seeds, prying open the phyllaries as seeds are developing, often consuming 90% of the seed crop of an individual thistle plant (McEachern and Pavlovic 2013). Miller High Dunes of IDNL has had up to 100% seed predation by goldfinches (Pavlovic, pers. comm. 2013). With the already small and declining populations of Pitcher's thistle at IDNL, the increase in goldfinch seed feeding has compounded the potential weevil threat (McEachern and Pavlovic 2013). (USFWS, 2016)

**Stressor:** Inadequate regulation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Government units below State level generally do not provide adequate protection for rare plants. A few townships passed zoning ordinances designed to protect some natural resources, but other townships with outdated zoning ordinances remain ill-equipped to deal with current development. At the State level, MDEQ continues to permit home development in Critical Dune Areas. Although permits may include conditions to avoid immediate loss of existing plants, these permits do not address fragmentation or potential alteration of dune-sustaining

processes. The State of Michigan has no authority to require protection of plants from indirect effects and does not require State-level endangered species permits if direct impacts to the species are not expected. In Wisconsin, State agencies do not have authority to protect listed species from impacts on private lands unless the activity otherwise requires a Federal permit or funding. (USFWS, 2016)

**Stressor:** Climate Change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. In the Great Lakes region, the climate will likely grow warmer and probably drier overall during the 21st century (Kling et al. 2003). Although average annual precipitation may increase slightly by the end of the century, seasonal precipitation cycles are predicted to become more extreme. Winter and spring rains are likely to increase, while summer rains are expected to decrease by up to 50 percent. These potential impacts of climate change are increasingly evident in the Great Lakes region. Summer lake water temperatures are increasing, with Lake Superior’s average summer surface water temperature increasing by 4.5° F since 1980 (Austin and Colman 2007). Ice forms later and melts earlier throughout the region. Earlier models had indicated that altered precipitation patterns, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000; AMEC 2006; Kling et al. 2003). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe et al. (2010) suggest that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lake levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios. If Great Lakes levels recede, more dune formation may occur, potentially increasing habitat for shoreline occurrences of Pitcher’s thistle (M. Penskar, Michigan Natural Features Inventory, pers. comm. 2009). Increased water temperatures will also result in decreased ice cover that when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000; AMEC 2006), altering Pitcher’s thistle habitat. A warmer climate could also bring about a northward shift and an even greater increase in invasive species that may be more problematic in the dunes and lakeshore systems, thus increasing competition with native plant species (Malcolm et al. 2002; AMEC 2006; Penskar, pers. comm.

2009). (USFWS, 2016)

**Stressor:** Development (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of the 2002 Recovery Plan, about 39% of the extant occurrences in the U.S. were in public ownership and an additional 20% occurred on a mix of public and private ownership. The public ownership includes populations at three National Park Service units, two National Forests, two National Wildlife Refuge units, several State Parks, and other types of protected State or local public lands. In addition, several PITH occurrences are on privately held land conservation lands (e.g., Door County Land Trust, Land Conservancy of West Michigan, Little Traverse Conservancy, Michigan Nature Association, The Nature Conservancy, etc.). In Canada, of the 30 total extant populations assessed in 2010, 4 small populations were noted in National or Provincial parks (COSEWIC 2010). As part of the Species Status Assessment, we will update and access the land ownership of the PITH occurrences as part of evaluating potential threats. Private lands supporting PITH are subject to both pressures for new development and shore protection for existing structures. Between 1992 – 2001, over 21% of all newly developed land within the Great Lakes watershed occurred within 10 km of the Great Lakes shoreline (an area which makes up 0.27% of the watershed) (Wolter et al. 2006). Much of this loss of shoreline habitat is due to urban or suburban sprawl, including second home development (Wolter et al. 2006). The strongest predictors of the distribution of second homes in the Upper Great Lakes were the presence of natural areas and the presence of water (Shellito 2006). When Great lakes water levels are high the demand for adding shoreline protection measures can increase significantly. The State of Michigan reported a nearly ten-fold increase in approved permits Great Lakes shoreline protection from Fiscal Year (FY) 2019 to FY2020's total (i.e., 2,238 shoreline protection permits approved in FY2020). Several PITH populations are also affected by sand mining (Slaughter and Cuthrell 2017). The loss and development of shoreline habitat makes it more difficult for shoreline ecosystems to shift in space with water level fluctuations as they once could (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 8C

**Delisting Criteria:**
1. The essential habitat associated with a total of 115 priority occurrences representing each biogeographic region and dune type is protected and managed under a management plan, including: a) all Federal and State owned essential habitat and occurrences, b) all publicly and privately-owned essential habitat and occurrences having a rank of A, AB, B, or BC, c) all occurrences in southern Lower Michigan, Indiana, and Wisconsin, and d) all complex perched dune systems. (USFWS, 2002)

2. Regular field surveys to verify occurrences and record new occurrences have been established. (USFWS, 2002)

3. Landowner contacts have been initiated and protection has been investigated for the remaining (rank < BC) public and private occurrences. (USFWS, 2002)

4. Monitoring of known sites shows a stable or increasing trend toward recovery and that protective plans are being implemented. (USFWS, 2002)

5. Restoration of two occurrences from among historical sites where sufficient habitat remains in Illinois, Indiana, Wisconsin, and southern Lower Michigan has been completed. (USFWS, 2002)

6. Research necessary to protect, manage and restore Pitcher's thistle has been conducted. (USFWS, 2002)

**Recovery Actions:**

- 1. Protect and manage known occurrences and essential habitat, giving priority to essential habitat. To ensure the long-term perpetuation of Cirsium pitcheri, planned protection for all 115 priority occurrences must occur and the remaining lower priority sites should receive some protection. Protection strategies will depend on cooperation between Federal and State agencies, private conservation organizations, regional planning councils, local jurisdictions, private developers and landowners. Principal cooperators include State and provincial resource agencies, The Nature Conservancy (TNC), The Nature Conservancy of Canada, the Center for the Great Lakes' Great Legacy program, the U. S. Forest Service (USFS), the National Park Service (NPS), and the U. S. Fish and Wildlife Service (Service). Working together should assure the highest level of protection for each site (USFWS, 2002)
- 2. Establish and conduct ongoing field surveys to verify known and record new occurrences. Pitcher's thistle is highly dependent upon the fluctuating environment of its lakeshore habitat. Therefore it is important to monitor the status of populations and habitats on a regular basis over periods of several decades to detect responses to fluctuating lake levels and habitat changes. Monitoring of sites is necessary for effective management. The monitoring should be designed to detect fluctuations in Pitcher's thistle population size and age class distribution and collect information on age at flowering. This will permit assessment of implemented management actions and determine if remedial action is required. (USFWS, 2002)
- 3. Inform the public, recreationists, public land managers, and private landowners. Knowledgeable individuals are an important part of the recovery process. Informing managers, recreational groups and landowners about Pitcher's thistle, its status as a protected species, and protection methods is an important step toward cooperative protection and management. Accurate and current information can foster interest and appreciation for the Pitcher's thistle. Groups such as the Michigan Nature Association, Michigan Natural Areas Council, The Nature Conservancy, The Nature Conservancy of Canada, Center for the Great Lakes, the International Joint Commission, Federal, State, provincial and local resource agencies, and local Audubon groups and garden clubs should be kept informed of recovery efforts. Federal land managers must be aware of the need to protect, and methods of protecting, Pitcher's thistle on Federal lands to facilitate decisions that will protect the species. Cooperators will develop, distribute, and update information and make recommendations for managers to protect Pitcher's thistle and its essential habitat. Information sent to individual managers will include the location of occurrences and

essential habitat, as well as the specific known and suspected threats to the species under the manager’s care. Public utilities, with their promotion of environmental programs, may underwrite or sponsor public awareness campaigns. Resource agencies may encourage greater conservation through liaisons with public utilities. (USFWS, 2002)

- 4. Monitor occurrences for stable and increasing trends and implementation of protective plans. Protective management of Pitcher’s thistle requires knowledge of its current status and threats. Inventory must incorporate population size, quality, and threats to be useful for scientific assessment and planning. (USFWS, 2002)
- 5. Restore Pitcher’s thistle to an element rank of at least BC on at least one appropriate site within its historical range. C. pitcheri has been extirpated from parts of its natural range, so restoration is necessary to recover Pitcher’s thistle throughout the area addressed in the recovery objective. Restoration is intended to recolonize sites where the species formerly occurred and cannot be used as justification or mitigation for destruction of an existing high quality occurrence elsewhere. Restoration planning should be integrated with ongoing interagency coordination and should be complementary and reinforcing. Restoration guidelines are needed in order to meet the objective of preserving populations throughout the species range. (USFWS, 2002)
- 6. Conduct research necessary for protection, management, and restoration. Answers to questions related to seed production, viability, dispersal distances, and predation would allow managers to assess risk to the species from different management scenarios. Improved understanding about the needs of Pitcher’s thistle would focus management goals for the species and lead to better protection of Pitcher’s thistle habitat(USFWS, 2002)
- Continue to plan and implement regular surveys, monitor occurrences, and document habitat conditions and population trends at all Pitcher's thistle locations. (USFWS, 2018)
- Monitor an approach of using biocontrol insects to manage non-native plant species. (USFWS, 2018)
- Seek funding opportunities to support research that addresses the following knowledge gaps: Demographic features of Pitcher's thistle populations located on Sleeping Bear Dunes National Lakeshore and other NPS properties within the Great Lakes region. Assess the threat of invasive weevils, including Larinus planus. . (USFWS, 2018)
- Work with partners to conduct a population viability analysis or similar for Pitcher's thistle . (USFWS, 2018)
- Complete Pitcher's Thistle Species Status Assessment (SSA) by 2024. Investigate whether possible extirpation of populations in southern Michigan is significant in terms of representation. (USFWS, 2018)

***Conservation Measures and Best Management Practices:***

- Recommendations for future actions • Continue to plan and implement regular surveys, monitor occurrences, and document habitat conditions and population trends at PITH locations. (Recovery Plan Action 2, 4 & 6)) • Monitor an approach of using biocontrol insects to manage non-native plant species. • Seek funding opportunities to support research that addresses the following knowledge gaps that assess the threat of invasive weevils, including Larinus carlinae. (Recovery Plan Action 4.41)) • Complete PITH Species Status Assessment by 2024. o Investigate whether possible extirpation of populations in southern Michigan is significant in terms of representation (USFWS, 2023).

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# SPECIES ACCOUNT: *Cirsium vinaceum* (Sacramento Mountains thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 06/16/1987; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

A robust perennial herb with a purple stem that grows up to 2 m tall. The deeply lobed, spine-tipped leaves can be as long as 5 dm. Many nodding, white to purple flower heads appear in late summer. The plant's nectar is highly attractive to hummingbirds, bees, and butterflies (NatureServe, 2015).

**Taxonomy**

It was originally named Carduus vinaceus in accordance with generic concepts at that time. Wooton and Standley (1915) later combined it with the genus Cirsium where it was maintained by Petrak (1917) in his revision of the North American species of Cirsium. Although Cirsium is a common genus in the New Mexico flora, Cirsium vinaceum is a distinctive species with no close relatives within its range of occurrence. Its closest relative is the Mexican species, Cirsium conspicuum (USFWS, 1993).

**Historical Range**

Endemic to the Sacramento Mountains of south-central New Mexico (Otero County) (USFWS, 2010).

**Current Range**

The range occurs approximately 6 mi northeast to 17 mi south of Cloudcroft. Greater than 95% of the known thistle habitats occur on the Lincoln National Forest (USFWS, 2010).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 2010); sexual (inferred from USFWS, 1993)

**Key Resources Needed for Breeding**

Adult: Insect and hummingbird pollinators (USFWS, 1993)

**Reproduction Narrative**

Adult: This species is a monocarpic, short-lived perennial initially forming robust rosettes of spiny leaves that live for one or more years as juvenile plants (Burks 1994). It is capable of root sprouting to produce multiple rosettes (clones) per genetic individual (USFWS, 2010). Pollen vectors include hummingbirds and numerous species of bees, beetles, flies, and moths (USFWS, 1993).

**Habitat Type**

Adult: Riparian (NatureServe, 2015); wetland (USFWS, 2010)

**Habitat Vegetation or Surface Water Classification**

Adult: Stream banks, wet meadows (NatureServe, 2015); conifer forest, valley (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: 2,460 - 3,020 m elevation (USFWS, 2010)

**Spatial Arrangements of the Population**

Adult: Dense patches (USFWS, 2010)

**Environmental Specificity**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits moist banks of streams, wet meadows, and other moist areas. Remaining populations are mostly in the vicinity of springs flowing out of limestone, where steep calcium carbonate deposits have formed. These receive less grazing and trampling than the surrounding flat areas and have provided a refuge for the species. The environmental specificity is moderate; it is an obligate wetland species that is dependent on streams or springs (NatureServe, 2015). It is endemic to elevations between 2,460 and 3,020 m. It is a wetland-obligate species inhabiting saturated alkaline soils in valley bottoms. Many of the travertine deposits are covered with dense patches of C. vinaceum to the point of being nearly a monoculture of this species (Thomson 1991). Thistle habitats occur in mixed conifer forests and open valleys (USFWS, 2010).

***Dispersal/Migration***

**Dispersal**

Adult: Low to moderate (inferred from USFWS, 2010; 1993)

**Dispersal/Migration Narrative**

Adult: Craddock and Huenneke (1997) determined that stream flow dispersal and occasional thistle establishment in streamside habitats were sufficient to genetically link some discrete patches of thistles (USFWS, 2010). The seed is heavy, but fairly dispersible by wind. Therefore, gene flow from pollen vectors and seed dispersal is probably effective up to about 0.5 mile (USFWS, 1993).

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2022)

**Species Trends:**

Declining (USFWS, 2022)

**Number of Populations:**

~20 (NatureServe, 2015)

**Population Size:**

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

**Population Narrative:**

Thirty-seven+ occurrences (10/96), but some may be part of a continuous population resulting in about 20 populations (11/12). Five populations were extirpated between 1995 and 2007 (10 - 30% decline). The estimated population size is 100,000 - 1,000,000 individuals (NatureServe, 2015). Overall, the Sacramento Mountains thistle appears to continue to be declining across all known locations; however, because survey methods used to count populations prior to 2010 were not available for replication, it is likely that surveys conducted in 2012 and 2018 undercounted the number of thistle rosettes. The population estimates recorded during 2012 were significantly lower that previous census counts (Roth, 2013) but remain relatively unchanged from 2013 to 2018, based on limited survey data from the Lincoln National Forest. Similarly, native and non-native insects are likely contributing to the species decline by depredating seeds and lowering the seed set, as well as lowering fecundity (Sivinski, 2007; Roth, 2013); however, the number of populations with predatory insects does not appear to have expanded beyond those identified by Roth in 2013. Fecundity may also be low due to low pollination success possibly caused by inbreeding depression; a phenomenon associated with small, isolated populations (Roth, 2013), or due to asynchronous timing between when thistles flowering and pollinator availability. Drought has likely played an increasing role in the number and distribution of Sacramento Mountains thistle by reducing overall habitat availability since the previous review was completed, with New Mexico experiencing years mixed with below average and above average precipitation. The role that drought has played in reducing the availability of habitat and resources has yet to be studied fully for the thistle. Declines in the thistle population size and distribution have mainly been contributed to a combination of drought, insect predation, and herbivory by livestock during the growing season (Roth, 2013), with no ranking of the threats provided. Some of these threats could be ameliorated using existing regulatory mechanisms (e.g., livestock herbivory) and some may be uncontrollable (e.g., insect predation, drought) by land management agencies. The Sacramento Mountains thistle is currently listed as a threatened species, i.e., one that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. As a wetland obligate species, the thistle occurs exclusively at springs, seeps, or drainage areas that are affected by drought and other resource management practices. Though there appears to be a continued decline of reproducing thistles, actual counts of reproductive individuals appear similar between surveys conducted in 2013 and 2018. The presence of predatory insects in thistle populations has been documented since the early 2000s. The apparent expansion of these insects into different populations of Sacramento Mountains thistle is likely an artifact of additional, targeted survey specifically looking for insect infestation. All other threats identified for the species in its recovery plan and in the last 5-year review remain unchanged; thus, because of the continued threats to this species, we recommend that the Sacramento Mountains thistle should retain its current listing status as a threatened species.(USFWS, 2022)

***Threats and Stressors***

**Stressor:** Water diversions/altered hydrology (USFWS, 2010)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Appropriation of water rights from springs for uses such as livestock water, farming, domestic use, or recreational facilities, usually uses points of diversion that curtail natural surface flows. One diversion for a residential subdivision currently is taking water from an aquifer on private property above a small thistle habitat in Fresnal Canyon and has been for several years (Sivinski, unpublished observation, 2005). Several thistle habitats have been subjected to direct and indirect impacts from land uses that damage travertine substrates and hydrological characteristics. Increasing population and associated agricultural and economic activities will require additional water from this relatively dry region (USFWS, 2010).

**Stressor:** Exotic weeds (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Huenneke and Thomson (1995) surmised that if a dense cover of teasel, or other exotic weeds, became established in thistle habitats, thistle germination would be inhibited by access to light, and the population might decline. Huenneke (1996) also noted that during drought, the drying soils in thistle habitats provided excellent conditions for teasel and other non-native plants, possibly lending non-natives a competitive edge in drier conditions (USFWS, 2010).

**Stressor:** Forestry (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, negative effects of timber harvest and management on Sacramento Mountains thistle habitat have been associated with roads and other surface disturbance that directly impacted thistle habitats or made changes in hydrology and erosion. Mortality to thistles growing in moist areas along roadsides occasionally occurs from mowing, road maintenance, or herbicides (Tonne 2007; Guaderrama, pers. Comm. 2007) (USFWS, 2010).

**Stressor:** Recreation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recreational impacts to Sacramento Mountains thistles from human destruction have been noted to occur at the Bluff Springs habitat location (USFWS 1993, USFWS 2008, Barlow-Irick 2008, USFS 2008b, USFWS 2010). Recreationalists have also been observed driving ATVs through exclosures typically fenced to exclude livestock; cut fences and opened gates have been noted in the same exclosed areas (USFS 2008b) (USFWS, 2010).

**Stressor:** Livestock and wildlife (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Grazing and trampling of Sacramento Mountains thistle by livestock and wildlife can reduce photosynthetic tissue, damage seedlings, rosettes, and flowering stems, as well as inflict hoof damage to travertine and soft substrates in occupied and potential habitat (Thompson

1991; USFS 1994). Thistle habitats on travertine springs and the soft-bottom valley habitats provide the majority of watering locations for livestock and elk. These fragile habitats are subjected to trampling and hoof damage. At present, Sacramento Mountains thistle habitats continue to be exposed to livestock with consistently detrimental effects to the thistle, particularly on the Sacramento Grazing allotment (USFS 2007) (USFWS, 2010).

**Stressor:** Insect damage (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Burks (1994) determined that overall seed predation by insects consumed or damaged roughly 17% of the seeds produced by this thistle before dispersal. Sivinski (2007, 2008) documented insect seed predation from four native and one introduced species, which damaged flower heads or cause premature stem death of the thistle. In September 2007, these insect predators significantly damaged flowering stems. Seed production from insect attack was significantly reduced from 2007 to 2009 in the Silver Springs population, particularly as a result of the stem boring weevil (Sivinski 2007, 2008, 2009b) (USFWS, 2010).

**Stressor:** Pesticides (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** USFWS Standards and Guidelines allow for the use of pesticides to control forest pests and such use is likely to adversely affect the thistle by reducing pollinator populations (USFWS, 2010).

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** For mountain tops in New Mexico, weather patterns remain unpredictable, yet most likely will reflect regional trends of warming and drying, leading to the shrinking of cooler and moister habitats associated with higher elevations (Agency Technical Work Group State of New Mexico 2005, Archer and Predick 2008). Drought conditions have been detected in the Sacramento Mountains based on decreased water flows at occupied springs and the contraction of the numbers and area occupied by Sacramento Mountains thistle (USFS 2007) (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
Not available

**Delisting Criteria:**
1. Acquire water rights specifically for the maintenance of travertine spring habitats at a minimum of 30 percent of the occupied spring localities, including at least 1 occupied spring locality in each of the 20 known canyons of occurrence (USFWS, 2010).

2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of at least 75 percent of the known occupied habitats according to steps outlined in the plans. Sites should include both core populations at springs as well as other occupied riparian habitats. Unoccupied steam habitat downstream of occupied springs should be protected for future colonization by the thistle (USFWS, 2010).

3. Establish a 10-year monitoring and research program to demonstrate the effectiveness of management implemented under the plans (USFWS, 2010).

**Recovery Actions:**

- Develop and implement a policy for spring development on LNF and acquire water rights to springs if in-stream flow legislation is ever passed in New Mexico (USFWS, 2010).
- Implement livestock management practices to protect plants and their associated spring and riparian habitats (USFWS, 2010).
- Implement logging practices that minimize indirect hydrologic and erosion effects on Sacramento Mountains thistle habitat (USFWS, 2010).
- Study impacts of exotic plant competitors and biological controls (USFWS, 2010).
- Conduct long-term monitoring to evaluate effectiveness of management (USFWS, 2010).
- Other (conduct genetic and hydrologic studies, locate new populations, manage recreation activities, engage in education and law enforcement) (USFWS, 2010).
- The recovery plan should be revised or amended. The criterion for acquiring water rights to maintain Sacramento Mountains thistle habitats does not reflect the legal challenges in obtaining such rights through legislation in the State of New Mexico. A revised criterion that also relies upon suitable points of diversion could have an additive effect on recovery, in conjunction with the existing criterion for water rights acquisition, should be considered. The recovery plan should also be amended to include criteria for uplisting Sacramento Mountains thistle to endangered species status (USFWS, 2010).
- The arrivals of an invasive seed-head weevil, Rhinocyllus conicus, and a stem boring weevil, Lixus pervestitus, in the immediate environment of Sacramento Mountains thistle are potential new threats to the survival of this threatened species. Additional research should be conducted to track the distribution of both weevil species in the Sacramento Mountains and the presence or absence of these weevils in Sacramento Mountains thistle seed heads and stems. Effects of R. conicus and native seed predators on seed production of the Sacramento Mountains thistle need to be ascertained (USFWS, 2010).
- Exclosures preventing livestock access to wetland thistle habitats should be constantly maintained. Resources to construct fencing around thistle populations exposed to livestock, especially those on the Sacramento Grazing Allotment, should be obtained and additional exclosures should be constructed to prevent thistles and promote thistle recovery (USFWS, 2010).
- Erecting signage, indicating the value and conservation status of the Sacramento Mountains thistle, should be considered at the Bluff Springs site (USFWS, 2010).
- continue to monitor invasive plants in thistle habitat. Should invasive thistle and teasel in the region continue to encroach upon Sacramento Mountains thistle habitats, hand-applied use of an EPA-approved, novel herbicide, aminopyralide, commercially known as Milestone, may be warranted (Fletcher, pers, comm. 2007) (USFWS, 2010).
- Monitoring of the Sacramento Mountains thistle populations, reproductive individuals, and rosettes should be conducted biennially by experienced biologists. Demonstrated impacts of

invasive wetland plants and insect predators in particular should be studied to prevent further population declines of the thistle. Interactions among thistle population trends in response to grazing, exclosures, invasive plants, and insect herbivory, along with predictions of warmer average temperatures and potentially less average precipitation potentially associated with climate change, should be monitored to direct future management for the thistle (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Establishing a specific survey protocol and methodology to document population trends and gain an accurate assessment of population size and extent would be beneficial for the thistle. Additionally, threats that could be managed through landowner action such as livestock herbivory and water development/diversion should be reduced to the maximum extent practical and monitored to determine existing and on-going impacts to the Sacramento Mountains thistle. A species status assessment to inform a recovery plan revision should, when workload permits, be conducted to incorporate new information on the species. Research is needed to understand how predatory insects, inbreeding depression, or other factors that may exist are affecting thistles and provide management recommendations that would limit or prevent thistles from declining in population size and resilience. Investigation is also needed to determine if the acquisition of water rights under the existing water rights law established by the state of New Mexico is possible to protect habitat for the Sacramento Mountains thistle.

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# SPECIES ACCOUNT: *Cirsium wrightii* (Wright's marsh thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened

**Physical Description**

Wright's marsh thistle is a biennial (a plant completing development in 2 years, and producing flowers in its 2nd year) or a weak monocarpic perennial (a plant that flowers, sets seed, then dies), in the sunflower family (Asteraceae). The plant is prickly with short black spines and a 3- to 8-foot (ft) (0.9- to 2.4-meter (m)) single stalk covered with succulent leaves (Sivinski 1996, p. 1; Arizona Game and Fish Department (AGFD) 2001, p. 1). Numerous slender flowering branches emerge from the stalk, starting about one-third up the length of the plant stalk. The ends of the branches support one or a few small flowering heads, which have numerous slender phyllaries (a modified leaf associated with the flower) (Sivinski 1996, p. 1). Flowers are white to pale pink in areas of the Sacramento Mountains, but are vivid pink in all the Pecos Valley locations (Sivinski 1996, p. 1). Blooms March-August.

**Taxonomy**

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Asterales; Family: Asteraceae (Asters, sunflowers). Wright's marsh thistle is a wetland obligate that was originally collected in 1851 at San Bernardino Cienaga, Cochise County, Arizona (Gray 1853, p. 101; Smithsonian 1849, p. 1).

**Historical Range**

Mexico - Uncertain; U.S. - Arizona, New Mexico. Wright's marsh thistle has been extirpated from all previously known locations in Arizona (e.g., San Bernardino Cienega) (Sivinski 1996, pp. 1, 4, 9, 2006a, 2009a, p. 1, 2012, p. 2; Worthington 2002a, p. 4; Baker 2011, entire), many in New Mexico (Roswell, Lake Valley), and was misidentified and likely not ever present in Texas (Poole 1992, entire; 2010, entire; Sivinski 1996, p. 2). The status of the species in Mexico is uncertain, with few verified collections of the plant (Sivinski 2012, p. 5).

**Current Range**

In New Mexico, eight general confirmed locations of Wright's marsh thistle cover an area of approximately 43 ha (106 ac): Santa Rosa, in Guadalupe County; Bitter Lake National Wildlife Refuge (NWR), in Chaves County; Blue Spring, in Eddy County; La Luz Canyon, Karr/Haynes Canyon, Silver Springs, and Tularosa Creek, in Otero County; and Alamosa Creek, in Socorro County (Bridge 2001, p. 1; Sivinski and Bleakly 2004, p. 2; NMRPTC 2009, p. 1; Sivinski 1994, p. 1; Sivinski 1996, p. 2; Sivinski 2005, p. 1, 3–5; Sivinski 2009; USFWS 1998, p. 1; Worthington 2002, p. 1–3). In Otero County, the Sacramento Mountains have four unique populations of the species clustered within about 16 kilometers (km) (10 miles (mi)) of each other on the west slope of the mountains. The remaining four localities are widely disjunct, separated from the Sacramento localities by about 120 to 225 km (75 to 140 mi) and from each other by about 120 to 345 km (75 to 215 mi). In the Sacramento Mountains, two of these four localities occur on the Lincoln National Forest, one locality is on private land, and the remaining locality is on the Mescalero Apache Reservation. In the Pecos River Valley, one locality is on public lands on Bitter Lake NWR; one is on private land near Blue Springs and the Black River; and one is in the vicinity of Santa Rosa on private, municipal, and State lands. The remaining locality is on private land on

Alamosa Creek, Socorro County. Localities vary in relative population size from fewer than 20 individuals covering only about 0.02 ha (0.03 ac) at the Silver Springs locality (Sivinski 2012, p. 21), to several thousand individuals on Bitter Lake NWR, covering almost 9.3 ha (23 ac). (USFWS, 2020)

**Critical Habitat Designated**

Yes; 5/25/2023.

**Legal Description**

We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the Wright's marsh thistle (Cirsium wrightii), a thistle species from New Mexico. We also designate critical habitat. In total, approximately 156.8 acres (63.4 hectares) in Chaves, Eddy, Guadalupe, Otero, and Socorro Counties, New Mexico, fall within the boundaries of the critical habitat designation.

**Critical Habitat Designation**

Critical habitat units are depicted for Chavez, Eddy, Guadalupe, Otero, and Socorro Counties, New Mexico.

Unit 1: Santa Rosa, Guadalupe County, New Mexico. (i) Unit 1 consists of 26.6 hectares (ha) (65.7 acres (ac)) in Guadalupe County, New Mexico, and is composed of lands in State (12.65 ha (31.2 ac)), City of Santa Rosa (9.88 ha (24.4 ac)), and private (4.09 ha (10.16 ac)) ownership.

Unit 2: Alamosa Springs, Socorro County, New Mexico. (i) Unit 2 consists of 1.58 ha (3.9 ac) in Socorro County, New Mexico, and is composed of lands in private ownership.

Unit 3: Bitter Lake, Chaves County, New Mexico. (i) Unit 3 consists of 19.0 ha (47.0 ac) in Chaves County, New Mexico, and is composed of lands under Federal management, specifically the U.S. Fish and Wildlife Service's Bitter Lake National Wildlife Refuge.

Unit 4 has been excluded from this critical habitat designation. (10) Unit 5: La Luz Canyon, Otero County, New Mexico.

Unit 5 consists of 0.01 ha (0.03 ac) in Otero County, New Mexico, and is composed of lands under Federal management, specifically the U.S. Forest Service's Lincoln National Forest.

Unit 6: Silver Springs, Otero County, New Mexico. (i) Unit 6 consists of 0.38 ha (0.95 ac) in Otero County, New Mexico, and is composed of lands under Federal management, specifically the U.S. Forest Service's Lincoln National Forest.

Unit 7: Karr/Haynes Canyon, Otero County, New Mexico. (i) Unit 7 consists of 1.79 ha (4.42 ac) in Otero County, New Mexico, and is composed of lands in private ownership.

Unit 8: Blue Springs, Eddy County, New Mexico. (i) Unit 8 consists of 14.04 ha (34.7 ac) in Eddy County, New Mexico, and is composed of lands in private ownership.

**Primary Constituent Elements/Physical or Biological Features**

The physical or biological features essential to the conservation of Wright's marsh thistle consist of the following components:

(i) Water-saturated soils with surface or subsurface water flow that allows permanent root saturation and seed germination

(ii) Alkaline soils

(iii) Full sunlight

(iv) Diverse floral communities to attract pollinators

**Special Management Considerations or Protections**

Management activities that could ameliorate these threats include, but are not limited to:

(1) Conservation efforts to ensure sufficient water availability

2) managing livestock grazing via the use of exclosures

(3) control of native and nonnative plants via controlled burning or mechanical treatments

(4) spill prevention and groundwater protection during oil and gas development and mining

(5) watershed/wetland restoration efforts

(6) efforts to restore a diverse floral community sufficient to attract pollinators. These management activities would protect the physical or biological features for Wright's marsh thistle by providing for surface or subsurface water flow for permanent root saturation, soil alkalinity necessary for all life stages, the availability of direct sunlight for plant development, and habitat for pollinators to complete cross pollination of the thistle. Additionally, management of critical habitat lands would help limit the impacts of current risks to population viability.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: Cirsium wrightii can display life history traits of a biennial (a plant completing development in 2 years, flowering in its second year) or a weak monocarpic perennial (USFWS, 2017).

**Breeding Season**

Adult: Flowering occurs August to October

**Reproduction Narrative**

Adult: Flowering occurs August to October (USFWS, 2017). Pollination—Species of Cirsium may be pollinated by a wide variety of insects, including social bees, solitary bees, flies, and beetles (Powell et al. 2010, pp. 910–911; Sivinski 2017b, pers. comm.). Bees are the primary pollinators of C. wrightii, especially bumble bees (Bombus spp.), with butterflies also being common pollinators (Sivinski 2017b, pers. comm.). Bumble bees are large, strong fliers and some species frequently travel 1 mile (mi) (1.5 kilometer (m)) or more to patches of desirable forage plants (Osborne et al. 2008, p. 406). Sivinski (2017b, pers. comm.) observed bumble bees, black swallowtails (Papilio polyxenes), green June beetles (Cotinis nitida), and oblique syrphid flies (Allograpta obliqua), among other insect pollinators, visiting C. wrightii. Hummingbirds have been observed visiting C. wrightii flower heads as well, but it is unknown if hummingbirds affect much pollination of the plant (Keil 2006, p. 131). The presence of other species of native flowering plants may help to attract abundant pollinators, and thus also benefit Cirsium wrightii. This may be more important for western populations of C. wrightii, where there are fewer thistles. In the larger eastern populations, there are likely enough individual C. wrightii to attract pollinators (USFWS, 2017).

**Habitat Type**

Adult: In New Mexico, the species occurs in wet, alkaline soils in spring seeps and marshy edges of streams and ponds between 3,450 and 7,850 ft (1,152 and 2,393 m) in elevation (Sivinski 1996, p. 1; 2005a, pp. 3-4; Worthington 2002a, entire). C. wrightii appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009). Plants commonly found in areas inhabited by this species include Scirpus spp. (bulrush), Salix spp. (willow), Baccharis glutinosa (seepwillow), Helianthus paradoxus (Pecos sunflower), Juncus spp. (rush), and Typha spp. (cattail) (Sivinski 1996, pp. 2-5; Sivinski and Bleakly 2004, p. 2; Worthington 2002a, pp. 1-2).

**Habitat Vegetation or Surface Water Classification**

Adult: Palustrine habitat: Herbacious wetland; Terrestrial habitat: Desert; marshy wetlands (cienegas) near springs in otherwise semi-arid to arid areas. (NatureServe)

**Dependencies on Specific Environmental Elements**

Adult: Wright's marsh thistle appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009).

**Environmental Specificity**

Adult: Very Narrow (inferred from USFWS, 2014)

**Habitat Narrative**

Adult: Wright's marsh thistle is a wetland obligate (occurs only in water-saturated soils) that was originally collected in 1851 at San Bernardino Cienaga, Cochise County, Arizona (Gray 1853, p. 101; Smithsonian 1849, p. 1). In the New Mexico portion of the species range, C. wrightii appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009). Plants commonly found in areas inhabited by this species include Scirpus spp. (bulrush), Salix spp. (willow), Baccharis glutinosa (seepwillow), Helianthus paradoxus (Pecos sunflower), Juncus spp. (rush), and Typha spp. (cattail) (Sivinski 1996, pp. 2-5; Sivinski and Bleakly 2004, p. 2; Worthington 2002a, pp. 1-2).

***Dispersal/Migration***

**Dispersal**

Adult: Water/Wind

**Dispersal/Migration Narrative**

Adult: In addition, seed banks of C. wrightii may be reduced annually due to predation from insects and birds, by seed moving to non-habitat via wind or water dispersal, or by the germination of many seeds which grow into the sometimes thousands of rosettes that have been reported from sites (USFWS, 2017).

***Population Information and Trends***

**Population Trends:**

Unknown

**Species Trends:**

Unknown

**Number of Populations:**

8 populations in 5 counties (Otero, Chavez, Guadalupe, Eddy, and Socorro)

**Population Size:**

populations of 2 to ~18,000

**Population Narrative:**

There are eight general localities of Wright's marsh thistle extant within New Mexico. Additional historical populations have been extirpated, including at least two larger and two smaller populations in New Mexico, and the population at the type locality in Arizona. The population at BLNWR is likely the most robust, with between 14,000 to 18,000 individuals (Sivinski 2012, p. 30). Santa Rosa contains scattered localities throughout four sections of land, and some of these have been extirpated recently. However, the population in 2012 was estimated between 12,000 to 14,000 individuals (Sivinski 2012, p. 52). The population along Tularosa Creek has undergone a significant reduction since 1995 and now contains only four individuals (Sivinski 2012, p. 21). The remaining populations in the Sacramento Mountains are mostly small, containing from two to perhaps several hundred individuals (Sivinski 2012, p. 9-24). The populations at Blue Spring and Alamosa Springs were recently discovered. There have been no subsequent surveys at Blue Spring to determine whether this population is stable or declining. Alternatively, in 2012, the population at Alamosa Springs was estimated at 900 flowering individuals (Sivinski 2012, p. 9), indicating a relatively stable status since its discovery in 2005). An experimental planting of 61 rosettes occurred at Burro Cienega in 2011, but was not monitored during 2012 to determine success or failure. The collections from Texas were misidentified, and we conclude C. wrightii never occurred in the state. Finally, there is only one verified historic collection from Mexico, and no recent information on the status of the species from this population. For these reasons, the status of this species remains tenuous.

***Threats and Stressors***

**Stressor:** Agricultural and urban development

**Exposure:** Water withdrawal
**Response:**
**Consequence:**
**Narrative:** Past and present alteration of rare desert springs, seeps, and wetland habitats that support Wright's marsh thistle is a significant threat. The four largest localities of C. wrightii at Blue Spring, BLNWR, Santa Rosa, and Alamosa Creek have the potential to be further modified by ongoing and future water withdrawal. Changes in water tables throughout the range of C. wrightii have also resulted in diminished discharge from springs or complete loss of surface water. Therefore, there has been a trend of diminishing habitat quantity and excessive degradation of habitat quality for the species throughout its range, as a result of agriculture and urban development, diversion of springs, and drought.

**Stressor:** Introduced plants
**Exposure:** Increased fire risk, competition and changes in hydrology
**Response:**
**Consequence:**
**Narrative:** The presence of and effects from Phragmites australis (common reed) threatens C. wrightii localities through increased fire risk, competition, and changes in hydrology.

**Stressor:** Inadequate regulatory protection
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Wright's marsh thistle receives inadequate protection from the Clean Water Act. Similarly, the species lacks adequate regulatory protection from its various designationsa Forest Service sensitive species, or endangered status by the State of New Mexico because these designations only serve to notify the public of the species' status and do not require conservation or management actions. We are not aware of any other existing regulatory mechanisms. Wright's marsh thistle is currently threatened by the inadequacy of existing regulatory mechanisms. This will continue into the foreseeable future.

**Stressor:** Livestock Grazing (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the semi-arid southwestern United States, wet marshes and other habitat of Wright’s marsh thistle attract ungulates (e.g., livestock, elk, and deer) because of the availability of water and highquality forage (Hendrickson and Minckley 1984, p. 134). Livestock grazing is present at localities in the Sacramento Mountains, Santa Rosa, Blue Springs, and Alamosa Springs. At the Santa Rosa locality, photographs indicate that the growth of Wright’s marsh thistle and the integrity of its habitat have been negatively affected by livestock herbivory and trampling (Sivinski 2012 pp. 33–53). Dry periods likely increase the effects of livestock trampling and herbivory on Wright’s marsh thistle when other water and forage plants are not available (75 FR 67925). Grazing may be more concentrated within habitats similar to those occupied by Wright’s marsh thistle during drought years, when livestock are prone to congregate in wetland habitats or where forage production is greater than in adjacent dry uplands (USFS 2003, entire). Livestock may trample individual plants and eat the thistle when other green forage is scarce, and when the seedlings or rosettes are developing and abundant. Further, livestock may eat

mature plant inflorescences (the complete flower head), which could reduce seed production. For example, the threatened Sacramento Mountains thistle (C. vinaceum) (52 FR 22933), which is also found in New Mexico and associated with habitats similar to those occupied by Wright's marsh thistle, is eaten by livestock and appears to be the preferred forage at some times of the year. It may provide some of the only green forage during droughts (NMRPTC 2009, p. 2). Also, it is possible that livestock grazing within and adjacent to spring ecosystems could alter or remove habitat or limit the distribution of the thistle (USFWS 2017). (USFWS, 2020)

**Stressor:** Native and Nonnative Plants (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some native and nonnative plants pose a threat to Wright's marsh thistle and its habitat through habitat encroachment and competition for resources at most localities. The native plants include cattails (Typha spp.); nonnative species include the common reed (Phragmites australis), purple loosestrife (Lythrum salicaria), Russian olive (Elaeagnus angustifolia), saltcedar (Tamarix spp.), and Russian thistle (Salsola spp.) (Sivinski 1996, p. 6). These particular native and nonnative species all have the same effect on Wright's marsh thistle by functioning as invasive species with respect to the thistle's habitat. Though cattails and Wright's marsh thistle may have evolved in the same area, decreased water availability has altered habitat conditions such that cattails have a competitive advantage in Wright's marsh thistle habitat. These plants present unique challenges and potential threats to the habitat, including shade effects on Wright's marsh thistle seedlings and rosettes. For example, the common reed, a nonnative invasive plant introduced from Europe and Asia, increases the potential for wildfire and is increasing in density at some locations in New Mexico. The dense plant growth blocks sunlight to other plants growing in the immediate area and occupies all available habitat (PCA 2005, p. 1). The increase of the common reed in Wright's marsh thistle habitat is a current threat to the species through increased wildfire risk, competition, and changes in hydrology (impacts on degree of soil saturation), especially when habitat is disturbed through burning or drying. The impacts vary based on location, with the greatest impacts occurring at Santa Rosa, Bitter Lake NWR, Blue Spring, and Tularosa Creek. We expect that the threats caused by native and nonnative plant competition and habitat loss will likely continue and possibly intensify, due to lack of vegetation management practices at several locations (Santa Rosa, Blue Spring, Tularosa Creek) and the pervasiveness of native and nonnative plants despite ongoing efforts for habitat restoration at other locations (Bitter Lake NWR). As this species is comprised of small, isolated populations, the impacts of native and nonnative plants could pose a significant stressor to the thistle. Attempts to manage native and nonnative plants through herbicide use and mowing may also exacerbate effects to Wright's marsh thistle as these techniques are difficult to preferentially apply to only the native and nonnative plant species when habitat is shared. In addition, we expect increases in drought periods to exacerbate the effects of this stressor. (USFWS, 2020)

**Stressor:** Oil and Gas Development and Mining (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oil and gas development occurs within and adjacent (i.e., within 10 miles) of some areas occupied by Wright's marsh thistle including Santa Rosa, Bitter Lake NWR, and Blue Spring

(New Mexico State Lands Office, 2017; NMDGF 2007, pp. 18–19; NMDGF 2005, p. 35). There are also mining activities adjacent (i.e., within 5 miles) to other areas such as a potential beryllium mine at Alamosa Springs, and subsurface drilling and exploration of the mineral bertrandite on Sullivan Ranch near Alamosa Springs (New Mexico Mining and Minerals Division 2010; New Mexico State Lands Office, 2017; Sivinski 2012, p. 9). As of February 2020, the Service has no information on any new actions towards developing the potential beryllium mine at Alamosa Springs. The main impacts from oil and gas development and mining include the potential for contamination. Contamination from oil and gas development has been observed within close proximity (i.e., within 16 km (10 mi) of some Wright's marsh thistle localities (New Mexico State Lands Office, 2017). While laws and regulations related to water quality have reduced the risk of contamination in and near occupied locations from oil and gas production, the likelihood that a spill could impact these habitats is still present based on the high volume of oil and gas leases near these areas. Potential contamination from both oil and gas development and mining could have several impacts on plants (such as Wright's marsh thistle), including the following: increased available nutrients, which may favor competitive or nonnative plant growth; altered soil pH (either higher or lower), which can kill plants; absorption of chemicals, which can poison plants or cause poor growth or dead spots on leaves; and plant mortality. In addition, oil and other contaminants from development and drilling activities throughout these areas could enter the aquifer supplying the springs and seeps inhabited by Wright's marsh thistle when the limestone layers are pierced by drilling activities. An accidental oil spill or groundwater contamination has the potential to pollute water sources that support Wright's marsh thistle, and mining activities could alter or destroy habitat. The largest occupied habitat area is less than 16 ha (40 ac), and more than half the known populations are less than 2 ha (5 ac) in size. Even a small, localized spill has the potential to contaminate and destroy a population. The loss of even one of the eight populations would result in loss of representation and redundancy to the species as a whole. Because this species is comprised of small, isolated populations, these stressors could potentially negatively affect the thistle, but it is unclear whether these impacts would be localized or widespread stressors as the interaction between contaminant spills and groundwater and surface water hydrology is poorly understood. Therefore, we have determined that oil and gas development and mining functions as a stressor to the future viability of the species via impacts to water sources that provide habitat for Wright's marsh thistle. (USFWS, 2020)

***Recovery***

**Recovery Actions:**

- Establish additional grazing exclosures in riparian areas on Forest Service lands, on the Lincoln National Forest to support expansion of extant populations of Wright's marsh thistle.
- Investigate the possibility of reintroductions to historically occupied habitat where natural recolonization is unlikely. Transplants of rosettes within existing localities may also assist in the expansion of occupied habitat.
- Conduct additional surveys for Wright's marsh thistle particularly springs and cienegas in southeastern New Mexico and Mexico.
- Coordinate closely with BLNWR on management of the species. For example, investigate how Wright's marsh thistle responds to changing water levels on the refuge, when soils are not continuously saturated throughout the growing season.
- Develop a conservation strategy for the species, to guide coordinated conservation efforts by multiple partners. This strategy would also include an educational component to inform private and State landowners of wetland permitting requirements when they fill or drain

their lands.

- Monitor and evaluate whether insect predators are a threat to Wright's marsh thistle, particularly in Sacramento Mountains.
- Control populations of Pyhragmites Australis where they threatened Wright's marsh thistle.

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Southwest Region

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# SPECIES ACCOUNT: *Clarkia franciscana* (Presidio clarkia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/06/1995; California/Nevada Region (R8)

**Physical Description**

A slender, erect, herbaceous annual of the evening-primrose family (Onagraceae), 40 centimeters (16 inches) tall with few, very small, and narrow leaves. The lavender-pink petals have a lighter basal portion and a reddish-purple basal spot. The slender capsule is 2 to 4 centimeters (1 to 2 inches) long. Clarkia franciscana can be distinguished from Clarkia rubicunda (ruby chalice clarkia), a related species that may occur in the same area, by its petals that have irregular teeth on the apical margin (the edge near the tip). Clarkia rubicunda has petals that are rounded at the apex (Lewis and Raven 1958a) and usually twice the length of Clarkia franciscana (Lewis and Raven 1958a, Lewis 1977). (USFWS, 1998)

**Taxonomy**

The type specimen of Clarkia franciscana (Presidio clarkia) was collected by Peter Raven in 1956. Clarkia franciscana was described by Harlan Lewis and Peter Raven (1958a). (USFWS, 1998)

**Historical Range**

In California, in San Francisco County, and later found in Alameda County. (USFWS 1998).

**Current Range**

It is restricted to serpentine soils in grassland and coastal scrub communities and is known from only two locations within highly urbanized areas of the San Francisco Bay Area: 1) the Presidio of San Francisco (the Presidio) within the city and county of San Francisco, California; and 2) the Oakland Hills within the City of Oakland, Alameda County, California (Oakland Hills) 17 miles to the east of the Presidio population (USFWS, 2024).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Predominantly self-pollinated with possibility cross-pollination (USFWS, 2010)

**Dependency on Other Individuals or Species**

Adult: Presidio clarkia is thought to be predominately self-pollinated (Gottlieb and Edwards 1992, p. 2). Small halictid bees (sweat bees), however, have been observed visiting the flowers and could potentially be pollinators for the species (USFWS, 2024)

**Breeding Season**

Adult: May to July (USFWS, 2010)

**Reproduction Narrative**

Adult: Presidio clarkia flowers from May to July. Flowers develop from erect buds and set seed in late summer or early fall. It is thought to be predominantly self-pollinated; however, there is some evidence to suggest that small halictid bees (sweat bees) could potentially be pollinators for the species. Due to its mechanism of self-pollination, there is restricted genetic variability in the populations. (USFWS, 2010). Presidio clarkia is thought to be predominately self-pollinated (Gottlieb and Edwards 1992, p. 2). Small halictid bees (sweat bees), however, have been observed visiting the flowers and could potentially be pollinators for the species (USFWS, 2024)

**Habitat Type**

Adult: Grassland and coastal scrub communities (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: restricted to serpentine soil

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: special habitat requirements

**Site Fidelity**

Adult: high

**Habitat Narrative**

Adult: C. franciscana is known from only two locations within highly urbanized areas of the San Francisco Bay Area, California (the Presidio within the City of San Francisco [SF Presidio] and the Oakland Hills within the City of Oakland, Alameda County [Oakland Hills]), where the plant is restricted to serpentine soils in grassland and coastal scrub communities (Skinner and Pavlik 1994). Serpentine soils are formed from weathered volcanic (ultramafic rocks) such as serpentinite, dunite, and peridotite. The C. franciscana has adapted to the harsh environments of serpentine soils that limit plant growth: low calcium : magnesium ratios; lack of essential nutrients such as nitrogen, potassium, and phosphorus; and high concentrations of heavy metals (mineral toxicity).

***Dispersal/Migration***

**Motility/Mobility**

Adult: not mobile

**Dispersal**

Adult: limited

**Dispersal/Migration Narrative**

Adult: Not much information is available regarding the dispersal of this species (USFWS, 2010)

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019)

**Species Trends:**

Unknown (USFWS, 2019)

**Population Growth Rate:**

unknown

**Number of Populations:**

5 (USFWS, 2024)

**Population Size:**

In our 1995 listing rule we noted that although population sizes fluctuated greatly, the highest total of Presidio clarkia plants reported in “recent years” was about 8,000 (Service 1995, p. 6674). This consisted of approximately 4,000–5,000 plants in Redwood Regional Park, 230 plants at the other two known Oakland Hills locations (Service 1995, p. 6681), and the rest (2,770 to 3,770 plants) at the two Presidio locations. In our 2010 status review we provided several years of survey data indicating the population numbers we had reported at the time of listing were likely from the 1980s for Presidio populations, and from 1991 for the Oakland Hills population (Service 2010, pp. 14–17). Abundances since those times again showed large fluctuations but large overall increases at the Inspiration Point population in the Presidio (54,351 plants in 2009) and the Redwood Regional Park subpopulation in the Oakland Hills (105,420 plants in 2009) (Service 2010, pp. 14–15). Other surveyed populations and subpopulations were much smaller, however, with only 29 plants in the World War II Memorial population at the Presidio in 2009, and 20 to 548 plants in the various suburban Oakland Hills subpopulations in 2008 (Service 2010, pp. 16–17) (Service 2010, pp. 16–17) (USFWS, 2024).

**Additional Population-level Information:**

As described above, Presidio clarkia can be found in two general locations: the Presidio and the Oakland Hills (Service 2010, pp. 5–8). At the time of listing, two populations of the plant were known in the Presidio and three occupied areas were known in the Oakland Hills (Occurrence 4) (Service 1995, pp. 6673–6674). Population locations in the Presidio consisted of the World War II Memorial (Occurrence 1) and Inspiration Point (Occurrence 2) (Diversity Database 2023a, pp. 1, 3). A third population near McDowell Avenue (Occurrence 3) had previously been identified but was considered “possibly extirpated" at the time of listing because it had not been seen since 1908 (Diversity Database 2023a, p. 5). The three occupied areas in the Oakland Hills consisted of a large subpopulation in Redwood Regional Park (extending into Joaquin Miller Park), and two subpopulations in the suburbs to the south (Service 1995, pp. 6673–6674, 6681; Diversity Database 2009, Aug shapefile; Service 2010, p. 16). Although we originally referred to the three occupied Oakland Hills areas as “populations” (Service 1995, p. 6673), we now refer to them as “subpopulations” because they are within 0.25 miles of each other and thus constitute a single occurrence as defined by the Diversity Database (Diversity Database 2020, p. 10). In our last status review, we noted that a new population (Coastal Bluffs) had been experimentally introduced at the Presidio in 2008 (Service 2010, pp. 5, 10). We also noted that, of the three extant populations at the Presidio, only the one at Inspiration Point occurred naturally (Service 2010, p. 4). The World War II Memorial population had been reintroduced by artificial seeding in 1972. Seeds for that reintroduction, as well as for the experimental Coastal Bluffs population, were obtained from the Inspiration Point population (Chassé. 2021, p. 14). At the time of our last review, the Oakland Hills population (Occurrence 4) had increased to seven total subpopulations due to the discovery of four additional subpopulations in the suburbs south of Redwood Regional Park (Diversity Database 2009, Aug shapefile; Service 2010, pp. 6–8). Since our last review two additional subpopulations have been added to the experimentally introduced population at Coastal Bluffs in the Presidio (which does not yet have a Diversity Database occurrence number, and which has also been referred to as “Presidio Coastal Bluffs” and “Presidio Bluffs”) (Chassé and Forrestel 2015, p. 16; Chassé undated (c), p. 17; Diversity Database 2023a, entire; Chassé in litt. 2024a, p. 1). One of the new subpopulations is actually within 250 feet of the World War II Memorial population and about half a mile from other Coastal Bluffs subpopulations (Chassé undated (b), pp. 14–15; Chassé 2021, p. 15). It is treated as part of the Coastal Bluffs population because it is on land managed by the National Park Service, which conducts annual surveys of it (Presidio Trust 2002, pp. 3, 5; Chassé 2021, p. 14). The World War II Memorial population is on lands managed by the Presidio Trust. A new population has also been introduced on Presidio Trust lands at West Crissy Bluffs, close to or possibly in the same location as the extirpated McDowell Avenue population (Occurrence 3) (Chassé and Forrestel 2014, p. 14). New subpopulations were added to the World War II Memorial Population in 2015, and to the West Crissy Bluffs population in 2016 (Chassé 2016, p. 18; Chassé undated (a), p. 21). See Table 1a for a summary of the Presidio populations (USFWS, 2024).

**Population Narrative:**

This species is known to occur in only two locales, the Presidio in San Francisco County and Oakland Hills in Alameda County, California. Since the approval of the 1998 recovery plan, new locations for Presidio clarkia within these two locales have been either introduced or discovered. The 2010 5-year review for Presidio clarkia (Service 2010b) summarizes the introduction along the Pacific coast at the Presidio (“Coastal Bluffs” site) and the discovery of four additional sites in Oakland Hills (for seven total Oakland Hills sites). Since the 2010 5-year review, Presidio clarkia was also reintroduced at the historical “West Crissy Bluffs” site (also referred to as “McDowell Avenue,” CNDDB occurrence #3) at the Presidio (Chassé and Forrestel 2014). The CNDDB (2018) reflects all known Presidio clarkia sites in Oakland Hills (CNDDB occurrence #4), but has not been updated for the Coastal and West Crissy bluffs introductions at the Presidio. - Ongoing habitat restoration and enhancement at the Presidio and Redwood Regional Park have increased local distributions and abundances of Presidio clarkia at these managed sites. Inspiration Point (Presidio; CNDDB occurrence #2) and Redwood Regional Park (Oakland Hills) continue to be the largest and most productive Presidio clarkia sites. The average population estimates for a 1.0-hectare (2.5-acre) plot at Inspiration Point is 58,904 individuals (2006-2018) and for a 3.0-hectare (7.4-acre) plot at Redwood Regional Park is 59,758 individuals (2008-2011, 2014-2015, and 2017). Since monitoring began, abundances at the other Presidio clarkia sites did not exceed 2,000 individuals3 until 2018. The 2018 censuses recorded 2,924 and 3,223 individuals at the Presidio’s West Crissy Bluffs and WWII Memorial sites, respectively. Despite the recent increase in numbers, the likelihood that the West Crissy Bluffs site (or the Coastal Bluffs site) will continue to support Presidio clarkia is in question. - All of the seven Oakland Hills sites are likely the remaining portions of a single population that was fragmented by residential development. Six of the Oakland Hills sites contain only small patches of serpentine that are surrounded by residences, roads, and a tennis club. These sites, held by the City of Oakland or private landowners, are rarely monitored. Thus, the status of Presidio clarkia in these patches is currently unknown. Prior to 2010, these six Oakland Hills sites had abundances that ranged from 20 to over 1000 plants (summarized in Service 2010b). (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat disturbance (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The six small Oakland Hills sites remain unprotected and are especially vulnerable to erosion, roadside maintenance for fire management, competing plant species, and residential development. Presidio clarkia has likely persisted in some of these habitat fragments because the steep terrain is unconducive for development and landscaping. Thus, the terrain is also erosive and Presidio clarkia plants and seeds are subject to being washed into roads and disposed of. The habitat fragments that are not too steep and erosive are frequently mowed prior to seed set (R. Kanz, conservationist and Oakland resident, pers. comm. 2018; Service 2010b). Unlike the protected sites, the Oakland Hills fragments are not managed to reduce nonnative plant competition and trees are typically favored in residential areas. Plans for a residential development on the Crestmont Drive site are in process, though it is uncertain when the development will be constructed. The City of Oakland has not yet approved the lot divisions for the development because the requirements for a rare plant conservation easement have not all been fulfilled (M. Grefsrud, CDFW, pers. comm. 2018). At the Presidio in San Francisco County, Presidio clarkia at the West Crissy Bluffs site are threatened by the site’s small size, high disturbance rate, and position just below a road. Declining numbers of Presidio clarkia at the Coastal Bluffs introduction site could be due to inadequate seed input (only one year of seeding), or because the coastal climate and habitat are not suitable for Presidio clarkia (M. Chassé, pers. comm. 2018). (USFWS, 2019)

**Stressor:** Erosion and altered hydrology (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In 1978, the Ecology Trail was routed through a then unknown subpopulation of Clarkia franciscana at Inspiration Point. Since then, the trail has been fenced off but the Inspiration Point subpopulation of C. franciscana at the SF Presidio continues to be threatened by trail erosion, storm drain runoff, and other hydrologic issues. A storm drain flows directly into the Inspiration Point site. This is thought to potentially threaten the C. franciscana because, as observed at the War Memorial site, the species does not do well under wetter conditions.  - In the Oakland Hills, most of the subpopulations of Clarkia franciscana occur on very steep, highly erosive serpentine roadcuts, and, therefore, are vulnerable to altered hydrology and accelerated erosion resulting from human disturbance. The C. franciscana has become restricted to areas with steeper slopes and thinner soils in the Oakland Hills due to the invasion of nonnative annual grasses onto the deeper serpentine soils. The lower Tennis Club site within the Tennis Club/Sunrise subpopulation is highly vulnerable to altered hydrology and erosion due to its location in a steep gully between the Sunrise Assisted Living Facility and the Oakland Hills Tennis Club. Only the Chadbourne Way subpopulation and some patches of the Redwood Regional Park subpopulation are not currently threatened by erosion and altered hydrology do to their locations on more gentle slopes. - Until recently, concerns about landslides slowed residential

development on some of the steeper serpentine slopes in the Oakland Hills where Clarkia franciscana occurs. However, since the Federal listing of the species, many residential developments have been constructed on steep serpentine soils that may or may not have had C. franciscana. In some cases, these residential developments proceeded without environmental review. - The Crestmont Drive subpopulation of Clarkia franciscana may be threatened by altered hydrology and erosional gullying due to the construction of seven single family homes immediately upslope on Colgett Drive between 1998 – 2003. A local resident and member of Friends of Oakland's Endangered Species reports "observations of the site [Crestmont Drive] indicate the impacts of water from uphill properties [on Colgett Drive] may be causing rilling and erosion". (USFWS, 2010)

**Stressor:** Small populations (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Recovery Plan (Service 1998) recommends securing populations containing a minimum of 2,000 plants each (but preferably more). The probability of population persistence over the long-term is expected to be higher for larger populations because large size decreases the likelihood of reduced viability or population extirpations due to random demographic or genetic events (Barrett and Kohn 1991, Ellstrand and Elam 1993). Currently, only two of the nine subpopulations of Clarkia franciscana (Inspiration Point and Redwood Regional Park) exceed the criteria for containing a minimum of 2,000 plants. Thus, the C. franciscana continues to be threatened by habitat fragmentation, a small number of populations, and the small size of most of the subpopulations. (USFWS, 2010

**Stressor:** Loss of pollinators (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Clarkia franciscana is thought to reproduce primarily through self-pollination. However, small halictid bees (sweat bees) have been observed visiting the flowers and could potentially be pollinators for the species (Lewis and Raven 1958). Thus, the use of pollinators by the C. franciscana could be important for increasing gene flow among populations and maintaining the genetic variability of the species. A study by Gottlieb and Edwards (1992) verified the low intrapopulation genetic variability within the SF Presidio population and the Oakland Hills population (Redwood Regional Park) as is expected for a species that is predominately self-pollinated (Stebbins 1978). Species with small populations and low genetic variability, such as the C. franciscana, are at greater risk of extirpation from natural catastrophic events (disease, fire, and drought) (Menges 1991). The reproduction and genetic variability of the Clarkia franciscana could be threatened by the recent worldwide decrease in pollinators. Pollinators are threatened by the use of both regulated (e.g., malathion) and unregulated pesticides (e.g., pyrethroids) (Department of Pesticide Regulation 2006, Keith 2006, Service 2000). More recently, the decline in pollinators observed across North America has been attributed to introduced parasites, in particular the varroa mite (Varroa jacobsoni), which affects the honey bee (Apis millifera) (Nielsen 2006, National Research Council 2006). The potential effects of introduced parasites on C. franciscana pollinators are not known. Hafernik (2009), however, reported a rich diversity of bees at the SF Presidio, including 56 species representing 23 genera. The diversity and abundance of bees and other pollinators in the Oakland Hills is not known at this time. (USFWS, 2010)

**Stressor:** Loss of genetic diversity (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The SF Presidio and Oakland Hills populations of the Clarkia franciscana are separated by 17 miles and the San Francisco Bay resulting in two genetically distinct populations (Gottlieb and Edwards 1992). However, the genetic distinctiveness of the Oakland Hills population of C. franciscana could potentially be threatened by genetic swamping from C. franciscana plants of SF Presidio genetic stock (which had been cultivated for 40 years at Tilden Botanical Garden) planted by residents within the Oakland Hills. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. The Clarkia franciscana has evolved to adapt to the highly specific soil, environmental, and microclimatic conditions that are unique to the two locations where it occurs in the San Francisco Bay Area: the SF Presidio and the Oakland Hills. Observations at the War Memorial site demonstrate that the C. franciscana is not very tolerant of certain microclimatic conditions associated with this coastal location (cooler, wetter, and greater exposure to wind and fog) (Chassé et al. 2009). Thus, due to the highly restrictive soil, environmental, and microclimatic conditions under which the C. franciscana can grow, the species may be vulnerable to even small changes in climate. (USFWS, 2010)

**Stressor:** Competition from plant species (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Presidio clarkia, throughout its limited range, is threatened with competition from nonnative invasive grasses, native shrubs, nonnative trees, and native trees planted outside of their natural range. Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine, facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors (summarized in Service 2010b). Shrubs and trees compete by shading annual grassland plants. Trees also bury the nutrient-poor serpentine soil with a thick layer of organic material, which encourages further invasion of non-serpentine species. (USFWS, 2019)

**Stressor:** Atmospheric nitrogen deposition from air pollution (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Elevated atmospheric nitrogen deposition from air pollution is particularly harmful to the nutrient-poor serpentine grasslands where the Clarkia franciscana occurs because nitrogen is the primary limiting nutrient for plant growth on serpentine soils (Weiss 1999). The use of catalytic converters on vehicles has increased the availability of nitrogen in a form that is directly absorbed by plants (EBRPD 2009a). The excess nitrogen deposited leads to increases in nonnative annual grasses which outcompete the native flora (Fenn et al. 2003, Weiss 1999). Other potential effects of elevated atmospheric nitrogen deposition on plants in nitrogen-limited ecosystems (Wolkowski et al. 2008), such as that in which the Clarkia franciscana grows, include decreased diversity of mycorrhizal communities. Increased nitrogen deposition can also predispose plants to other environmental stresses such as elevated concentrations of ozone, drought, frost, or insect attacks. It is not known at this time if elevated atmospheric nitrogen deposition from air pollution impact C. franciscana mycorrhiza. (USFWS, 2010)

**Stressor:** Development (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Development remains a general threat for the subpopulations on private lots south of Redwood Regional Park. However, there do not appear to be any such development projects currently ongoing on occupied sites (Merkamp in litt. 2024, pp. 1–2). The Crestmont Project mentioned in our last status review (Service 2010, p. 28) has not been carried out (Grefsrud in litt. 2024a, p. 1), leaving both the proposed 4-lot residential development and the accompanying 0.85 acre managed conservation easement (Service 2010, p. 28), unimplemented. Mitigation measures mentioned in our last review for construction of the Sunrise Assisted Living Facility (Service 2010, p. 30) have not been carried out either, despite construction of the facility (Grefsrud in litt. 2024b, p. 1). These measures included removal of invasive French broom (Genista monspessulana) and development of an approved revegetation and monitoring plan (Service 2010, p. 30). (USFWS, 2024)

**Stressor:** Mowing (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mowing, including string trimming, currently remains a threat for the suburban subpopulations south of Redwood Regional Park. Mowing requirements in those subpopulations differ according to land ownership. The city of Oakland owns the land supporting the Chadbourne Way subpopulation, as well as those portions of the Old Redwood Road subpopulation that are west of Old Redwood Road (Alameda County Assessor's Office (Alameda Assessor) 2024, pp. 1, 57). Note that we described the Old Redwood Road subpopulation as occurring entirely on cityowned land in our last review (Service 2010, p. 8), but most of it is actually on private land. For over a decade, the City of Oakland has been mowing the areas as a method of fire prevention, using string trimmers in May or June and then raking and removing the cut material (Kanz in litt. 2023, pp. 1–2). Since Presidio clarkia seeds typically mature in late

summer or early fall (Service 2010, p. 3) such practices likely prevent new seeds from maturing and germinating and may have contributed to the absence of Presidio clarkia plants at the Chadbourne Way subpopulation in recent years (USFWS, 2024)

**Stressor:** Competition (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition with non-native and woody plants remains an issue at all monitored locations (Chassé undated (c), p. 17; Naumovich 2021, pp. 14, 15). Non-native competitors at the Presidio include invasive grasses and tocalote (Centauria melitensis), while woody competitors include California blackberry (Rubus ursinus) and poison oak (Toxicodendron diversilobum) (Chassé undated (c), p. 17). Since our last review, the National Park Service has continued vegetation removal treatments, which involve pulling and cutting by hand in the areas supporting Presidio clarkia, and use of landscape fabric and string trimmers in adjacent areas (USFWS, 2024)

**Stressor:** Inbreeding Depression (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Populations that become small too quickly can suffer genetic impacts such as inbreeding depression because they randomly lose beneficial gene variants as the population shrinks (Soule 1980, pp. 157–158). This is less of a threat to species with a seed bank, such as Presidio clarkia, because gene variants lost from the plant population in a given year may be preserved in the seed bank and return in a subsequent year. However, the Chadbourne Way subpopulation has been mowed and raked on a yearly basis, and may now be reduced to a relatively few viable seeds (see Mowing, above). The entire subpopulation, including the seed bank, may have thus been reduced to very low numbers over several years. This would leave it vulnerable to inbreeding depression, if still extant. (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
A/1: A minimum of five populations of Presidio clarkia, which shall include Inspiration Point at the Presidio and Redwood Regional Park in Oakland Hills, are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat and known former habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2019)

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

E/1: Each population described in A/1 contains a minimum of 2,000 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

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

E/3: Impacts from competing plant species are managed so they do not pose a threat to the persistence of any of the Presidio clarkia populations described in A/1. (USFWS, 2019)

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

Recovery Priority Number: 5C

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

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

A/3: Each of at least six of the populations described in A/1 are contained in a protected area comprised of at least 12 hectares (30 acres) of rehabilitated serpentine grassland. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years79 that include two normal precipitation cycles, each population described in A/1 exhibits a stable or increasing population trend with a minimum of 2,000 individuals81 each year. (USFWS, 2019)

E/2: For a minimum of 20 consecutive years82 that include two normal precipitation cycles, each of the six populations described in A/3 contains a minimum of 28,000 individuals84 each year with a rolling 20-year average of at least 140,000 individuals. (USFWS, 2019)

E/3: The populations described in A/1 adequately represent the genetic diversity present in the range of the species. At least two of the six populations described in A/3 represent the genetic diversity of Presidio clarkia at the Presidio and another two of six populations represent the genetic diversity in Oakland Hills. (USFWS, 2019)

E/5: The populations described in A/1 occupy serpentine grasslands with negligible nonnative plant cover and with species-appropriate disturbance regimes such as grazing and/or burrowing mammal populations. Impacts from competing plant species are managed so they do not pose a threat to the persistence of Presidio clarkia in any of the populations described in A/1. (USFWS, 2019)

E/6: Long-term management of Presidio clarkia habitat is both practically and financially sustainable. Active management is not required more frequently than once every 5 years. Financial resources for long-term habitat management are secured. (USFWS, 2019)

**Recovery Actions:**

- 1. Protect Presidio clarkia sites and establish additional populations. 1.1. Identify and protect potential introduction sites. (Priority 1). 1.2. Develop and implement a seed increase or collection program that represents the breadth of genetic diversity in the species. (Priority 1). 1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous introductions may be necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 1). 1.4. Secure populations through land acquisitions, conservation easements, or other means. (Priority 1). 1.5. Work with the City of Oakland and private landowners to maintain Presidio clarkia sites for the long-term survival of the species on their lands. Collaboratively determine the best management practices to accomplish both landowner objectives and conservation goals. Educate local roadside maintenance crews and landscapers. (Priority 1). (USFWS, 2019)
- 2. Research Presidio clarkia life history and conservation strategies. 2.1. Conduct genetic research on existing populations to determine the species' genetic structure and diversity. (Priority 2). 2.2. Research optimal habitat characteristics, mechanisms of dispersal, pollination biology, seed viability of populations from both the Presidio and Oakland Hills, and potential impacts from climate change. (Priority 2). 2.3. Study the demography and reproductive biology of populations. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage Presidio clarkia populations. 3.1. Implement site-specific management plans for Presidio clarkia and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). . Best habitat management practices may include complete eradication of nonnative species and restoration of native serpentine plant communities. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)
- 1. Implement and evaluate the effectiveness of the habitat enhancement recommendations suggested by Weiss and Neiderer (2009) and EBRPD (Appendix B in EBRPD 2010) (e.g., tree removal, reseeding, scraping, fall tarping, fall flaming (post-germination), spring mowing, and installation of protective fencing), for increasing the survivorship of Clarkia franciscana, controlling nonnative annual grasses, and expanding C. franciscana populations into adjacent areas . (USFWS, 2010)
- 1a. The effectiveness of various habitat enhancement measures may vary dependent on sitespecific conditions as observed in the different results obtained in studies of the SF Presidio (Weiss and Neiderer 2009) and Oakland Hills (EBRPD 2010) populations. Monitor the results, determine the best treatment intervals, and adaptively manage. (USFWS, 2010)

- 1b. Expand Clarkia franciscana plants into adjacent areas of suitable habitat by collecting clarkia seeds from nearby plants and actively seeding in areas of bare ground and low cover of nonnative annual grasses. Collect seeds at different times in the season from C. franciscana plants throughout the adjacent areas, from large and small individuals, to capture a range of genetic diversity (Appendix B in EBRPD 2010). To avoid overcollecting, seed collection should be limited to less than 1 percent of the seedset in the first year while efficacy is being tested (EBRPD 2010). (USFWS, 2010)
- 1c. Persuade private landowners in the Oakland Hills (e.g., Oakland Hills Tennis Club, Sunrise Assisted Living Facility, and the proposed Crestmont development) to monitor the Clarkia franciscana subpopulations on their lands and control invasive species as required under their management plans that were developed during the CEQA process (e.g., Center for Biological Diversity 2007; Kanz in litt. 2009; EBRPD 2009b; City of Oakland 2006b). (USFWS, 2010)
- 1d. Persuade the City of Oakland and private landowners in the Oakland Hills (e.g., Colgett Drive, Kimberlin Heights Drive, and Crestmont Drive) to remove trees where they have been planted in suitable Clarkia franciscana habitat as is being done at Redwood Regional Park and the SF Presidio. (USFWS, 2010)
- 2. Reintroduce Clarkia franciscana to suitable habitat at the SF Presidio (restored site at the West Crissy serpentine grassland near McDowell Avenue; historic location for the species) (Chassé et al. 2009). (USFWS, 2010)
- 3. Address storm drain runoff and erosion issues at Inspiration Point in the SF Presidio and at Crestmont Drive in the Oakland Hills. (USFWS, 2010)
- 4. Increase education of City of Oakland road maintenance and vegetation and fire management teams in how to avoid and minimize impacts to the Clarkia franciscana including delaying their activities (e.g., mowing and weed-whacking) in areas with C. franciscana (Chadbourne Way, Old Redwood Road, and Redwood Regional Park subpopulations) until after the clarkia have set seed (late summer, early fall). (USFWS, 2010)
- 5. Analyze the genetic diversity among the seven subpopulations of Clarkia franciscana within the Oakland Hills. Store seeds representing the genetic diversity within the Oakland Hills population at the University of California Botanical Garden, Berkeley, California, and the Rancho Santa Ana Botanic Gardens, Claremont, California. Also collect seeds from the SF Presidio population of C. franciscana for storage at the Rancho Santa Ana Botanic Gardens, Claremont, California. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several conservation and monitoring recommendations, which we believe will aid in the recovery of the Presidio clarkia. Some of these recommendations have already been discussed in our previous status review (Service 2010, pp. 56–57) and remain valid. 1. Continue non-native and woody plant removal at the Presidio and Redwood Regional Park, now that these practices have been shown to be effective. Continue efforts to expand Presidio clarkia occupied habitat where possible (primarily at Redwood Regional Park). 2. Seek funding to resume monitoring of all Presidio clarkia occurrences at the Presidio. Also seek funding and qualified personnel to monitor subpopulations in the suburbs south of Redwood Regional Park. If any of those subpopulations have been extirpated (such as at Chadbourne Way), seek funding, personnel, and agreements with landowners to reseed the area and re-establish the subpopulation. 3. Support adoption of the vegetation management plan currently proposed by the

City of Oakland. Work with the City to amend the Fire Code to allow the rare-plant protections in the vegetation management plan to be applied on private lots. Work with the City to support management and monitoring of Presidio clarkia in Joaquin Miller Park. 4. Obtain seeds from all five Presidio clarkia occurrences and store them at a second certified botanic garden such as the Rancho Santa Ana Botanic Gardens in Claremont, California. Also store seeds from the Presidio populations, and from Oakland Hills subpopulations other than Crestmont, at the UC Botanical Garden (which currently only has seeds from the Crestmont site) (USFWS, 2024).

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# SPECIES ACCOUNT: *Clarkia imbricata* (Vine Hill clarkia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/21/1997; California/Nevada (Region 8)

**Physical Description**

An erect annual herb in the Onagraceae (Evening primrose) family, growing up to 60 centimeters (2.5 feet) tall, with unbranched or numerous short branches in the upper parts. This plant is densely leafy, with entire (smooth leaf margins), lanceolate leaves (tapering to a point at the apex and sometimes at the base) 2.0 to 2.5 cm (0.8 to 1.0 in long and 4 to 7 mm (0.2 to 0.3 in broad that are ascending and overlapping. Showy inflorescences appear from late June through July. Flowers are grouped closely together and each flower has a conspicuous funnel shaped tube at its base and four fan-shaped, lavender petals 2.0 to 2.5 cm (0.8-1.0 in) long with a V-shaped purple spot extending from the middle to the upper margin of the petal. Clarkia imbricata is distinguished from other morphologically similar Clarkia species by the broad, overlapping, ascending leaves. (USFWS, 2015)

**Taxonomy**

In 1953, Frank H. Lewis and Margaret Lewis described Clarkia imbricata from specimens collected on July 10, 1951, along Vine Hill Road, near Pitkin Ranch in Sonoma County, California. Clarkia imbricata is distinguished from other morphologically similar Clarkia species by the broad, overlapping, ascending leaves. (USFWS, 2015)

**Historical Range**

Same as current range. (USFWS, 2015)

**Current Range**

Vine Hill Area, Sonoma County, California. in the area of Vine Hill Road between the cities of Forestville and Santa Rosa. (USFWS, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (self-fertilization) (USFWS, 2015)

**Lifespan**

Adult: 1 year (USFWS, 2015)

**Breeding Season**

Adult: June to August (USFWS, 2015)

**Reproduction Narrative**

Adult: Clarkia imbricata is self-compatible (capable of self-fertilization). Plants begin to flower in June, and often bloom through August. Seeds generally set in early September. It is not known when seeds germinate or how flowers are pollinated. As with many annual plants, numbers can vary substantially from year to year, depending on seasonal weather variations. (USFWS, 2015)

**Habitat Type**

Adult: Palustrine wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Herbaceous wetland, grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Restricted to open grassland near freshwater marsh at elevations between 60 to 75 m (California Native Plant Society, 2001) (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: All known populations of Clarkia imbricata have been found between 60 to 75 meters (197 to 246 feet) elevation, on what has been mapped as Goldridge acidic sandy loams, in an area sometimes referred to as the Sonoma Barrens. Clarkia imbricata is restricted to Vine Hill region on Goldridge acidic sandy loam soil series. Historically the vegetation growing in the Vine Hill region was “chaparral or Sonoma barren”, a mixture of chaparral and Douglas-fir/oak woodland, mixed evergreen forest in the canyons and freshwater marsh and riparian habitat along Pitkin, Green Valley and Atascadero Creeks in Sonoma County. C. imbricata inhabited open grassy portions of this area. (USFWS, 2011)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (inferred from USFWS, 2015)

**Dispersal**

Adult: Low (inferred from USFWS, 2015)

**Dispersal/Migration Narrative**

Adult: Clarkia imbricata plants would likely be unable to shift their range naturally because of their dependence on specific soil characters, climate, the presumably low dispersal-potential of the species, and natural and anthropogenic barriers to dispersal (agriculture and housing developments).

***Population Information and Trends***

**Population Trends:**

Previous reports have described the population trend to be increasing and stable (USFWS 2011, 2016). However, recent data suggest the population has declined in the past decade. (USFWS, 2019)

**Number of Populations:**

1 (USFWS, 2024)

**Population Size:**

Variable; past surveys have noted from 60 to 10,900 plants (USFWS, 2024)

**Additional Population-level Information:**

The only known, extant population of Vine Hill clarkia exists at the Vine Hill Preserve (preserve) in Sonoma County, California. The preserve is owned and managed by CNPS volunteers (USFWS 2016; K. Symonds, in litt. 2018). Historically, there were as many as three locations where the plant existed in central Sonoma County. All known populations existed on Goldridge acidic sandy loam soils, in an area known as the Sonoma Barrens. Past surveys have documented as many as 8,700 plants and as few as 60 plants at the reserve, suggesting a high degree of population variation at the site, typical of annual plant species (USFWS 2016; S. Gordon, in litt. 2018). Previous reports have described the population trend to be increasing and stable (USFWS 2011, 2016). However, recent data suggest the population has declined in the past decade. Vine Hill clarkia continues to be located only within the 0.6 hectare (1.5 acre) Vine Hill Preserve (K. Symonds, pers. comm. 2018; S. Gordon, pers. comm. 2018). (USFWS, 2019). Distribution: Prior to listing, three occurrences of Vine Hill clarkia were known: (1) along the roadside of Vine Hill Road north of Guerneville Road (Lewis-type); (2) east of Vine Hill Road, off Sequoia Circle (Sequoia Circle); and (3) along a path to Pitkin Marsh and on a dry slope bordering Pitkin Marsh (Pitkin Ranch) (Service 2016, p. I-2). All three occurrences were within 0.4 miles of each other (Service 2016, p. I-2). By 1974, the Lewis-type occurrence was believed to have been extirpated (Service 2016, p. I-2). Sometime between 1981–1984, the Pitkin Ranch occurrence was believed to have been extirpated (Service 2016, p. I-2). At the time of listing in 1997, the Vine Hill clarkia was known to be distributed between the naturally occurring Sequoia Circle occurrence and an out-planted population within the California Native Plant Society, Milo Baker Chapter's Vine Hill Preserve – herein, Vine Hill Preserve. The naturalized population at the Vine Hill Preserve was created in 1974 or 1975 from seed collected at Sequoia Circle (Service 1997, pp. 55794). The Sequoia Circle population has not been surveyed since listing (Service 2011, p. 6); however, the population has likely been extirpated due to a change in ownership and cessation of land management practices conducive for the species' success (Service 2011, p. 2; Service 2016, pp. I-2, I-5). The Vine Hill Preserve remains the only known, presumed extant occurrence of this species. In recent years, Vine Hill clarkia have also been seen moving onto a neighboring property (Service 2011, p. 6; S. Gordon, Laguna de Santa Rosa Foundation, pers. comm. 2023). Abundance: Prior to listing, little abundance information for any of the three-known natural sites was maintained (Service 2016, p. I-2). As mentioned above, the Lewis-type locality was extirpated in 1974. The Pitkin Ranch locality declined after its habitat was converted to a Christmas tree farm around 1976 (Service 2016, p. I-2). Survey efforts for the Pitkin Ranch locality in 1977, 1978, and 1981 noted a few plants growing, but the species ultimately disappeared from the site following 1981 (Service 2016, p. I-2). At the time of listing, the Sequoia Circle occurrence contained between 2,000 to 5,000 plants and the Vine Hill Preserve supported between 200 to 300 plants (Service 1997, p. 55794). Shortly after listing, the ownership of Sequoia Circle changed, and the new owners did not continue land management practices that had previously benefited the species (Service 2016, p. I-2). Based on the current land management practices and poor condition of the plants at the time of last survey, it is unlikely the site continues to support Vine Hill clarkia (Service 2016, p. I-2) The out-planted population at Vine Hill Preserve has fluctuated significantly. Since the last 5- Year Review, the population has demonstrated an overall upward trend, including during drought years. Additional out-plantings occurred at the Vine Hill Preserve in 2019 and 2020 and resulted in successful reproduction. The out-plantings and follow-up surveys are further discussed in the Conservation Efforts section. Refer to Table 1 below for the assessed total number of Vine Hill clarkia individuals at the Vine Hill Preserve since 1978. As mentioned above, some Vine Hill clarkia plants have also been observed on a neighboring property. This property has been routinely mowed in June before the Vine Hill clarkia sets seed, so the number of individuals there remains low and often unquantified (USFWS, 2024).

**Population Narrative:**

Narrowly endemic to a small area in Sonoma County, California. Historically, four populations were known; currently, there is one natural population, with a total of about 5000 plants, and one planted population with < 400 plants (NatureServe, 2015). Based on monitoring by The Nature Conservancy and CNPS, in 1978, 60 plants were observed; from 1988 to 1993, the population fluctuated from about 200 to 300 plants; and, from 2007 to 2012, the population fluctuated from approximately 500 to 8,781 plants. In 2013, the population of C. imbricata at Vine Hill Preserve was estimated at 908 individuals (S. Gordon, personal communication 2013) and in 2015 was estimated at 270 plants (S. Gordon, personal communication 2015). The number of C. imbricata plants on the property to the east of the Vine Hill Preserve fluctuates from zero to 100 plants, depending on property maintenance activities. In 2010, the area occupied by C. imbricata on the Vine Hill Preserve was measured at 1,540 square meters (16,576 square feet), up from 1,467 square meters (15,791 square feet) in 2009. (USFWS, 2011; USFWS, 2015; NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Land use conversion (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing in 1997, the most significant threat to the two remaining populations of Clarkia imbricata was extirpation through land use conversion to housing, vineyards and orchards. Land use conversion is now lesser threat given that of the two populations that existed at the time of listing, only one is known to remain and it is on the Vine Hill Preserve which is protected by the California Native Plant Society (CNPS). The second population (Sequoia Circle) was on private land with restricted access and plants have not been surveyed since 1997. The extant Vine Hill Preserve population is protected, monitored and managed by CNPS, but the plants growing on the adjacent property are not protected. Thus habitat destruction, modification or curtailment due to land use conversion remains a threat, but a lesser one than at the time of listing. In 2011 land use changes on the adjacent parcel reduced the available habitat for C. imbricata. (USFWS, 2011)

**Stressor:** Shading and nonnative species (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Another mechanism for habitat destruction, modification or curtailment that is probably a greater threat than at the time of listing is succession of the grassland habitat that Clarkia imbricata requires. This threat has increased because there is now only a single known population that is restricted to the open, grassy area of the Vine Hill Preserve. The open area will decrease if the grassland is allowed to progress through successional stages into chaparral and forest. This will shade C. imbricata and enrich the soil with leaf litter which may encourage competing non-native species such as Holcus lanatus, a perennial plant that reseeds readily and can tolerate fire. Invasive species such as Holcus lanatus threaten C. imbricata through competition for space and resources. In areas where H. lanatus grows, C. imbricata is shaded and grows at a lower density. H. lanatus has increased in numbers over the last few years in an area of the Vine Hill Preserve that lies under trees growing on a neighboring property (S. Gordon, personal communication 2010). (USFWS, 2011)

**Stressor:** Over-collection (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, the Vine Hill Preserve population of Clarkia imbricata was threatened by over-collection and damage associated with trespassing by recreational plant enthusiasts seeking not only the C. imbricata plants and seeds, but also Arctostaphylos densiflora and Ceanothus foliosus var. vineatus, ostensibly for the nursery trade. However at this time overcollecting is not thought to be a major threat, as no incidents have occurred within the last 10 years (P. Van Soelen, personal communication 2010). Therefore over collection remains a threat, but less so since 1997. (USFWS, 2011)

**Stressor:** Risk of extirpation due to small population sizes (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Risk of extinction through random events was listed as a threat in the 1997 listing rule. The small number of individuals in the single Clarkia imbricata population increases the threat of extinction of the species as a whole through stochastic demographic and environmental events. C. imbricata has been reduced to a single protected population with fluctuating numbers of individuals. Even with as many as 5,000-10,000 plants in an annual plant population, risk of extirpation due to small populations is a major threat because we do not know enough about population dynamics, and annual plant numbers can vary greatly between years. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Global climate change was not included in the 1997 listing rule, but is a potential threat to Clarkia imbricata. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). C. imbricata may be at risk with global climate change if it cannot disperse to favorable climate and conditions. (USFWS, 2011)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of the listing, regulatory mechanisms thought to provide protection to Clarkia imbricata included: 1) listing under the Endangered Species Act; 2) the National Environmental Policy Act (NEPA); 3) listing under the California Endangered Species Act (CESA); 4) the California Environmental Quality Act (CEQA); and 5) the California Native Plant Protection Act (NPPA). In summary, the Act is the primary Federal law that provides protection for Clarkia imbricata since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Federal Endangered Species Act. (USFWS, 2011)

**Stressor:** Destruction of habitat (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing in 1997, the most significant threat to the two remaining populations of Vine Hill clarkia was land conversion to housing, vineyards, and/or orchards (Service 1997, p. 55799). The 2011 5-Year Review described the threat of land conversion of occupied habitat as a lesser threat given that the single extant occurrence of the species was protected on the Vine Hill Preserve, while all natural populations had been extirpated (Service 2011, p. 6). At the time of the 2016 Recovery Plan and 2019 5-Year Review (Service 2016, p. I-6; Service 2019, p. 3), land-use conversion remained a lesser threat to the known extant occurrence of Vine Hill clarkia. However, the few plants that are growing on the adjacent property to Vine Hill Preserve are not protected, and current land-use and management activities on the adjacent property may reduce available habitat for the species (USFWS, 2024)

**Stressor:** Competition and reduced fire regime (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Vine Hill clarkia is a shade intolerant species and is restricted to open areas as it is easily outcompeted for light and space by large shrubs and trees. The 2011 5-Year Review identified competition by overshading species and natural succession of the grassland habitat in the Vine Hill Preserve as a major threat (Service 2011, p. 7). Invasive non-native species were also documented as a threat; common velvet grass (Holcus lanatus) was present in the Vine Hill Preserve and continues to compete with the Vine Hill clarkia (Service 2011, p. 7; Laguna de Santa Rosa Foundation 2023, pp. 4, 5, 8). In the 2016 Recovery Plan and 2019 5-Year Review, the threat of competition was highlighted, particularly as it related to the state-endangered Vine Hill manzanita (Arctostaphylos densiflora) (Service 2016, p. I-9; Service 2019, pp. 3–4). While the Vine Hill manzanita and Vine Hill clarkia likely co-occurred naturally in various habitats, they are both now only found naturally in the Vine Hill Preserve (Service 2019, p. 4). Natural fire regimes keep succession in balance and maintain open areas; however, with reduced fire regimes due to fire suppression, artificial maintenance to control community succession is necessary to support Vine Hill clarkia (Service 2016, p. I-9). At the time of this review, the threat of competition remains at

the Vine Hill Preserve, though the immediate risks have been ameliorated due to the decline in Vine Hill manzanita from Phytophthora infection and managed seeding of Vine Hill clarkia throughout areas previously occupied by manzanita (Gordon pers. comm. 2023). Additionally, the Vine Hill Preserve Management Plan was created in 2023 to guide management of the Preserve for the perpetual success of the Vine Hill clarkia, Vine Hill manzanita, and state-rare Vine Hill ceanothus (Ceanothus foliosus var. vineatus) (Milo Baker Chapter 2023, entire). This Plan provides protocols and recommendations for removal of native and nonnative competitive species, through methods like hand pulling and controlled burns when feasible (USFWS, 2024)

**Stressor:** Pesticides (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. The pollinators of Clarkia species are diverse and include species of specialized and generalist bees, flies, and beetles (Anderson et. al. 2021, entire). The Agency's final biological evaluations determined that all three pesticides are highly toxic to bees and other invertebrate pollinators, have the potential to result in bee brood and colony reductions, and if affected pollinators decline near Vine Hill clarkia, there is a potential for the three pesticides to indirectly adversely affect the species (Agency 2022a, pp. 4, Appendix 4-1; Agency 2022b, pp. 2, Appendix 4-1; Agency 2022c, pp. 3, Appendix 4-1). The Agency anticipates releasing amended proposed interim decisions and a national consultation with the Agency is currently pending. (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
E/1. There are three separate locations with C. imbricata, each consisting of 2 acres or more, and each with a 10-year average of 4,000 plants or more. Due to the longterm persistence of the species at the Vine Hill Preserve (smaller than 2 acres) and the successful management of the site by CNPS, the Vine Hill Preserve may be counted as one of the three locations if it meets all other aspects of the downlisting criteria. For the purpose of meeting this criterion, a separate location is defined as a group of C. imbricata plants sufficiently separated from any other group of C. imbricata as to minimize the potential that a typical single stochastic event (e.g., fire or storm damage) would affect more than one location with C. imbricata. (USFWS, 2015)

E/2. Develop a management plan to control competing native and non-native vegetation. Competing native and non-native vegetation should be controlled at a level whereby years with less than 4,000 C. imbricata plants at each location counted towards recovery (as defined in delisting criterion E/1) cannot be attributable to competition with native and non-native vegetation. Also, there is a monetary commitment in place to continue control in perpetuity for all locations counted toward recovery (as defined in downlisting criterion E/1). (USFWS, 2015)

A/1. All populations of C. imbricata counted toward recovery, as defined in E/1, are protected from incompatible uses with a binding legal commitment from the landowner, and funding has been secured for the perpetual implementation of the management plans defined in E/2. (USFWS, 2015)

Recovery Priority Number: 5

**Delisting Criteria:**
A/1. All populations of C. imbricata counted toward recovery are protected from incompatible uses with a binding legal commitment from the landowner, and funding has been secured for the perpetual implementation of the management plans. (USFWS, 2015)

E/1. There are five separate locations with C. imbricata, each consisting of 2 acres or more, and each with a ten year average of 4,000 plants or more . Due to the longterm persistence of the species at the Vine Hill Preserve and the successful management of the site by CNPS, the Vine Hill Preserve (smaller than 2 acres) may be counted as one of the five locations if it meets all other aspects of the delisting criteria. For the purpose of meeting this criterion, a separate location is defined as a group of C. imbricata plants sufficiently separated from any other group of C. imbricata as to minimize the potential that a single stochastic event (e.g., fire or storm damage) would affect more than one location with C. imbricata. (USFWS, 2015)

E/2. Competing native and non-native vegetation are controlled to a level whereby years with less than 4,000 C. imbricata plants at each location counted towards recovery (as defined in delisting criterion E/1) cannot be attributable to competition with native and non-native vegetation. Also, there is a monetary commitment in place to continue control in perpetuity for all locations counted toward recovery (as defined in delisting criterion E/1). (USFWS, 2015)

**Recovery Actions:**
- Establish additional populations of Clarkia imbricata. (USFWS, 2015)
- Monitor and manage competing native and non-native vegetation affecting Clarkia imbricata. (USFWS, 2015)
- Conduct research for the development of a population viability analysis, determine levels of genetic diversity and interbreeding coefficients, and model the rate at which genetic diversity can be expected to be lost to genetic drift. (USFWS, 2015)
- Protect, manage, and increase the population where possible within its native range. If appropriate areas that are not within the native range are found, reintroduce C. imbricata. (USFWS, 2011)
- Establish at least two additional separate populations on protected land. (USFWS, 2011)
- Control of succession and nonnative plants where possible through hand removal of vegetation. (USFWS, 2011)
- Explore the use of a burn box to determine how fire affects C. imbricata seed bank and germination, in addition to nonnative species such as Holcus lanatus seed bank and germination. (USFWS, 2011)
- Gather information about life history and the ecosystem requirements of Clarkia imbricata. More specifically, gather information about how long the seed bank remains viable and how it responds to fire, germination requirements, and genetic diversity. (UFSWS, 2011)

- Create and implement a monitoring plan for Clarkia imbricata. Yearly plant counts are already conducted. Add estimation of percent cover of nonnative species and percent cover by shrubs and trees.
- Monitor land-use conversion in parcels adjacent to Vine Hill Preserve. If development occurs, attempt to rescue plants or seeds if possible. (USFWS, 2011)
- Control and monitor access to the Vine Hill Preserve to prevent and monitor trespassing. (USFWS, 2011)
- Pruning and managing the extent of Vine Hill Manzanita. Reports suggest the Vine Hill clarkia and Vine Hill manzanita coexisted naturally in the Sonoma Barrens prior to European settlement (USFWS 2016). Today, both plants only exist at the Vine Hill Preserve. In previous years, Vine Hill clarkia existed in the margins between individual Vine Hill manzanitas. Currently, the Vine Hill manzanita have grown to a point that they are shading and excluding the Vine Hill clarkia from these areas, limiting the number of individual clarkia which can grow at the site. We suggest pruning the Vine Hill manzanita to increase the amount of available habitat for the Vine Hill clarkia. This will require coordination with the California Department of Fish and Wildlife, as the Vine Hill manzanita is a state listed species. (USFWS, 2019)
- Continued seeding upslope. Vine Hill clarkia populations could be dispersal limited (S. Gordon, pers. comm. 2018). Upslope areas at the Vine Hill Preserve previously contained plants (S. Gordon, pers. comm. 2018); however, today the population has shifted spatially within the preserve to areas where its survival is threatened by competition with the Vine Hill manzanita (USFWS 2016). This threat would decrease if individual Vine Hill clarkia seeds were collected and distributed upslope habitat every few years. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Vine Hill clarkia. Some of these recommendations have already been discussed in the previous status reviews (Service 2011, pp. 10–11; Service 2019, p. 4) and remain valid. 1. Continue managing competing vegetation at Vine Hill Preserve. 2. Continue out-planting at different locations at Vine Hill Preserve to increase occupied habitat. 3. Build communication with the landowners of the properties neighboring Vine Hill Preserve and those with assumed extirpated localities in order to survey those sites, secure protection, and create management plans. 4. Monitor land-use conversion in parcels adjacent to Vine Hill Preserve. If development occurs, attempt to rescue plants or seeds, if possible. 5. Identify and consider permanently protecting locations within the Vine Hill clarkia's historical range that contain suitable habitats for future out-plantings. 6. Attempt out-planting at protected locations on private and public land within the Vine Hill clarkia's historical range. (USFWS, 2024)

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# SPECIES ACCOUNT: *Clarkia speciosa ssp. immaculata* (Pismo clarkia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 1/17/1995; California/Nevada (Region 8)

**Physical Description**

An annual herb, with branched stems, in the four o'clock family (Onagraceae). It is up to 50 cm (20 in) tall and has flowers 1.5 to 2.5 cm (0.5 to 1.0 in) wide that are white or cream colored at the base, streaking into pinkish or reddish-lavender at the tips. (USFWS, 2009)

**Taxonomy**

A member of the four o'clock family (Onagraceac), was first collected in Carpenter Canyon by Frank Harlan Lewis and Margaret Ensign Lewis in 1947. Their monograph on the genus Clarkia (Lewis and Lewis 1955) described the plant for the first time (USFWS, 1998). Clarkia speciosa ssp. immaculata differs from the more abundant ssp. speciosa in having somewhat larger flowers with a different petal-color pattern (lacking a red spot); genetic studies (Lewis and Lewis, Univ. Calif. Publ. Bot., 1955) showed "considerable" genetic differentiation between these two subspecies. (NatureServe, 2015)

**Historical Range**

See Current Range.

**Current Range**

Western San Luis Obispo County, California, ranging from San Luis Obispo south to the Nipomo Mesa area, an area approximately 20 kilometers (km) (13 miles (mi)) long by 10 km (7 mi) wide. (USFWS, 2009). Pismo clarkia's range increased to an area approximately 35 km by 13 km or 22 mi by eight mi from what we estimated it to be in 2009 (22 km by 10 km or 14 mi by seven mi; Service 2009, pg. 5). When we simply trace the circumference around the outermost datapoints on Figure 1, the taxon's range occupies approximately 40,359 hectares or 99,730 acres (USFWS, 2023).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 1998)

**Breeding Season**

Adult: May through July, occasionally extending into September (USFW, 1998)

**Reproduction Narrative**

Adult: Pismo clarkia is an annual herb that typically flowers from May through July, occasionally extending into September. (USFWS, 1998). The reproductive biology of Pismo clarkia is not well studied. All C. speciosa have relatively large, showy flowers with eight stamens arranged in two series of four and a stigma that is distinctively four-lobed. The mature style is longer than the stamens and situated above them. It reaches maturity after the stamens (called protandry), and this is believed to have evolved to encourage outcrossing and help ensure that self-fertilization does not occur. However, all species in the genus are self-compatible (Lewis and Lewis 1955, pg. 246, 249, 289). Selfing evolved independently from other outcrossing species within Clarkia at least 10 times but is likely not utilized for reproduction in C. speciosa because of its persistent protandrous floral morphology (Moeller and Geber 2005, pg. 787). While selfing may occasionally occur in C. speciosa, most successful reproductive events occur via outcrossing with insect pollinators. Based on studies from other Clarkia species, potential pollinators of C. speciosa may include both specialist and generalist bees, flies, butterflies and moths, beetles, and hummingbirds (Lewis and Lewis 1955, pg. 249; Moeller 2005, pg. 30–31; Miller et al 2014, pg. 320–321). However, evaluations of floral visitors and pollinators for taxa within C. speciosa have not occurred. We do not know how long Pismo clarkia seeds remain viable. Seeds likely persist in the soil as a seedbank based on observations by researchers that Pismo clarkia plants did not appear in the same locations in consecutive years (Service 1998, pg. 33). Other research showed that C. williamsonii seeds remained viable and ungerminated as a seed bank in any given year of monitoring (Price et al 1985, pgs. 154–155). C. springvillensis seeds stored at room temperature were not viable after eight years. However, they remained viable for at least two consecutive years of study (McCue and Holtsford 1998, pg. 33). Therefore, we presume Pismo clarkia is similar to many other California native annual plants that produce seeds with multiyear dormancy and make large, and potentially long-lasting soil seed banks (USFWS, 2023).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest Edge, Forest/Woodland, Old field, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs at elevations below 600 feet (USFWS, 1998)

**Spatial Arrangements of the Population**

Adult: Patches (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Pismo clarkia typically occurs in fine, dry, sandysoils, derived from ancient marine terraces, in grasslands or openings in chaparral and oak woodlands at elevations below 600 feet. Due to the patchy distribution of these openings, C. speciosa subsp. immaculata populations (and polygons within each population) are fragmented by nature. (USFWS, 1998; USFWS, 2009)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

26 populations. Of these, two are extirpated, six are likely extirpated, four are at least partially extant, four are extant, and 14 are presumed extant. We also know of two other occurrences where development projects are proposed, and these are presumed extant (USFWS, 2023)

**Population Narrative:**

Currently, there are 14 populations listed within CNDDB that are extant or presumed to be extant. While more populations have been found in recent years, the overall status of this species is not improving. Development has adversely affected or threatens to adversely affect nine of the remaining 14 known populations and fragmentation due to development is a serious concern for the survival of the species as a whole. (USFWS, 2009). Pismo clarkia currently consists of 26 known CNDDB occurrences. Of these, two are extirpated, six are likely extirpated, four are at least partially extant, four are extant, and 14 are presumed extant. We also know of two other occurrences where development projects are proposed, and these are presumed extant. Lastly, we know of 17 georeferenced Pismo clarkia herbarium specimens, although we do not know the status of the taxon at these locations. We have little current information about Pismo clarkia abundance throughout the range and are unable to assess any trends about the status of the taxon, even at the scale of individual occurrences. At this time, we have met none of the downlisting criteria established for the taxon and therefore delisting criteria are not considered (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Development and secondary impacts from development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Residential development and other secondary impacts associated with urban development continue to be the greatest threat to the continued existence of Clarkia speciosa subsp. immaculata. Development has caused the loss of all or part of five known populations of this species since listing. Development has affected or continues to threaten nine additional populations in part or in whole (Roalman 2000, CNPS 2006, CNDDB 2009). In addition to direct loss of plants and occupied sites, development eliminates adjacent suitable habitat that otherwise would allow for natural population expansion and movement as suitable microhabitats shift in the landscape. Furthermore, it may eliminate habitat that supports populations of pollinators and seed dispersal vectors and habitat that contains a seedbank, in cases where there is no germination in a given year when surveys are conducted. (USFWS, 2009)

**Stressor:** Urban sprawl and development (USFWS, 2009)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Urban sprawl and development leads to habitat loss and increased fragmentation and is the number one cause of imperilment to listed species, including Clarkia speciosa subsp. immaculata, in California (Doyle et al. 2001). Likewise, urban sprawl and development are directly linked to introduction of and competition from non-native species and outdoor recreation, the second and third leading cause in the decline of listed species, including C. speciosa subsp. immaculata (Alberts et al. 1993, Doyle et al. 2001). The fragmentation of habitat and populations due to development projects may pose the greatest threat to the recovery of the species. Commercial and residential development is rapidly increasing within areas in close proximity to existing and potential C. speciosa subsp. immaculata habitat (Draeger 2002), leading to a substantial increase in fragmentation of populations since listing. A large increase in the amount of development (e.g., residential, recreational, infrastructure) within this area has occurred between populations, which may have increased their isolation from each other (CNDDB 2005; AirPhotoUSA Inc. 2000, 2003; USDA National Agricultural Image Program 2005; M. Elvin, Service Biologist, pers. obs. 2006). Additionally, numerous development projects have further fragmented individual populations by extirpating portions of them (CNDDB 2005; AirPhotoUSA Inc. 2000, 2003; USDA National Agricultural Image Program 2005; L. Althouse, pers. comm. 2006). (USFWS, 2009)

**Stressor:** Habitat fragmentation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat fragmentation affects persistence of populations or species within habitat fragments (Wilcove et al. 1986, Noss et al. 1997). Fragmentation also may lead to a decrease in pollination and reduced reproductive success, due to decreased visitation from pollinators to small and/or isolated populations (Kearns and Inouye 1997). While fragmentation does not necessarily lead to extinction of a species within a habitat patch, small populations in small habitat patches have an increased likelihood of extinction and are increasingly affected by their surroundings (i.e., edge effects such as physical effects differing at the boundaries of a patch and the interior of a patch) (Noss and Cooperrider 1994). At what point in the fragmentation process biological integrity of this species declines dramatically is not known. (USFWS, 2009)

**Stressor:** Habitat degradation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The CNDDB indicates that many of the properties containing Clarkia speciosa subsp. immaculata populations have been proposed for development since listing (CNDDB 2005), although many of these projects either have not occurred yet or have fallen through (L. Althouse pers. comm. 2009; Google Earth 2009). We know of two instances where the translocation of C. speciosa subsp. immaculata populations (soil and seedbank) was attempted in an effort to mitigate for impacts to portions of the original populations due to development (EO 16 and 17). Plants survived during the monitoring and management phases of these projects, but after the monitoring and management ended, the sites became so degraded and the vegetation/habitat was altered to the point that suitable habitat for C. speciosa subsp. immaculata no longer exists at any of the sites. Plants have not been seen at these locations since 1998 and all of these sites (original donor populations and the recipient translocated populations) are now presumed to be

extirpated (J. Dart, pers. comm. 2006; L. Althouse, pers. comm. 2006; M. Elvin, pers. obs. 2006; CNDDB 2009). Therefore, all of the known translocation efforts for C. speciosa subsp. immaculata have failed and the translocation of populations of this species may not be a sufficient mitigation or conservation strategy. (USFWS, 2009)

**Stressor:** Non-native plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cortaderia jubata (pampas grass) and Ehrharta calycina (veldt grass) are nonnative plants adversely affecting many populations (CNDDB 2005, 2009; L. Althouse pers. comm. 2009), and their invasions are most likely an indirect effect from nearby development and plants that escaped from landscaping. (USFWS, 2009)

**Stressor:** Roadside threats (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats and adverse effects from road grading, roadside traffic, and roadside maintenance (including mowing and herbicide spraying) have not caused the extirpation of any entire occurrence, but they continue to threaten the species as a whole. At least three occurrences are threatened by road maintenance activities (CNDDB 2005, CNPS 2006, CNDDB 2009). (USFWS, 2009)

**Stressor:** Cattle grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** We noted that two of the four known extant occurrences (at that time) had been subject to grazing by livestock (Service 1994), but that C. speciosa subsp. immaculata might be able to sustain a certain amount of grazing by livestock (Dunn 1987). Although cattle grazing may adversely affect Clarkia speciosa subsp. immaculata, it may not necessarily be a threat to its survival under all conditions. If controlled and timed correctly, cattle grazing may provide some benefits to C. speciosa subsp. immaculata by reducing competition from other vegetation. Over-grazing, on the other hand, can be extremely detrimental to the species, particularly through trampling and alterations to the hydrology (Service 1997, 1998). While this plant may be able to withstand a small amount of grazing, grazing still appears to adversely affect it through the reduction of reproductive success due to loss of flowers and a correlated reduction in the production of seeds (Service 1998). Grazing has been reported as a potential threat at four occurrences (CNDDB 2009). (USFWS, 2009)

**Stressor:** Stochastic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Clarkia speciosa subsp. immaculata may be threatened with stochastic extinction due to the small number of individuals within populations and isolation of the remaining populations (Airphoto USA Inc. 2000, 2003; CNDDB 2009). It is generally accepted that small populations

have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Soulé 1987, Shaffer 1981, 1987; Meffe and Carroll 1997, Primack 1998). (USFWS, 2009)

**Stressor:** Isolation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Another factor commonly understood to make populations vulnerable to stochastic events is isolation. Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (i.e., colonization is less likely as isolation increases) (Wilcox and Murphy 1985, Meffe and Carroll 1997). (USFWS, 2009)

**Stressor:** Isolation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In addition, wide fluctuations in numbers from year to year in annual plants, such as Clarkia speciosa subsp. immaculata, may reduce population viability if there is a series of poor seed production years (Menges 1991). The limited gene pool may depress reproductive vigor or a single human-caused or natural environmental disturbance (e.g., wildfire) could extirpate one or more populations of this species. Additionally, small populations are threatened by inbreeding depression and can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the time of listing, we have identified climate change as a potential threat to the species. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. Clarkia speciosa subsp. immaculata may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap with regions that would be climatically suitable in the future (Levine et al. 2008). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**

1. Eight populations are on lands secured from human-induced threats with adequate surrounding habitat to permit natural population expansion and movement as suitable microhabitats shift in the landscape. (USFWS, 1998)

2. The eight protected populations represent the plant's entire range. (USFWS, 1998)

3. These populations must be large, stable or increasing (a minimum of 10 years of monitoring is needed because the population sizes fluctuate due to precipitation). (USFWS, 1998)

4. Management of these populations and associated lands in the future must be reasonably assured for the long term, and must be effective, as demonstrated by stable or increasing populations. (USFWS, 1998)

Recovery Priority Number: 6C

**Delisting Criteria:**
When the downlisting criteria have been met for a species, the species can be considered for delisting if:

(1) Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species; (USFWS, 2019)

(2) An ex situ seedbank is established in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that an occurrences could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019)

(3) All existing occurrences are stable or increasing in the wild for at least 10 years. We expect above-ground occurrence size to fluctuate annually, based on response to amount and timing of rainfall. Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region. Monitoring of occurrences should be undertaken and access to private properties that support the species should be pursued, which will provide a baseline for the status of these occurrences; these data should provide a basis for monitoring occurrence attributes and trends to determine the species trajectory over time. (USFWS, 2019)

**Recovery Actions:**
- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts ofeasement orfee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are

adjacent to high density residential and urban development. (USFWS, 1998)

- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity ofthe recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion ofmaintaining sufficient numbers ofpopulations or conservation areas should be assessed, and the success or failure of management actionsshould be evaluated. (USFWS, 1998)
- Recommendations for Actions from 2009 5-Year Revview: Work with local partners to secure occupied sites that meet recovery criteria. Work with local partners (including the County of San Luis Obispo) to help development projects avoid impacts to Clarkia speciosa subsp. immaculata, considering the two attempted translocation projects for this species have failed, resulting in the presumed extirpation of both populations. Work with the County of San Luis Obispo to develop an improved system to track projects that might adversely affect listed and other sensitive species. Amend the recovery objectives and tasks to account for the increase in fragmentation and how it affects our ability to accomplish the recovery criteria. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access (if possible) to all mapped Pismo clarkia occurrences to conduct comprehensive surveys of abundance, assess the status of the taxon, and evaluate threats at these locations. Include estimates of numbers of individuals present, global positioning system (GPS) mapping of occupied spatial area, ecological setting, co-occurring and codominant vegetation, presence of natives versus nonnative species, timing of phenology, and observations of potential insect pollinators. Update information in resource agency databases (CNDDB) to ensure that these data remain accurate and current. 2. Pursue grants and other funding to purchase properties that support the taxon and other plausible mechanisms to secure occurrences from development threats. Acquisitions should also include endowments to manage Pismo clarkia and its habitat in perpetuity. 3. Conduct experimental research on strategic, applied grazing as a management tool for Pismo clarkia recovery and nonnative, invasive weed controls. 4. Conduct experimental research across the species' range to improve and refine our understanding of techniques for population reintroduction, augmentation, and establishment. 5. Continue making accessions for conservation seed banking throughout the species; range so that all populations are represented in the collections. Conduct seed bulking of accessions that may serve as a source for recovery efforts and a backup in the event of stochastic loss and local extirpation (USFWS, 2023).

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# SPECIES ACCOUNT: *Clarkia springvillensis* (Springville clarkia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/14/1998; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

An erect annual herb, up to about 1 m tall. Flowers (May-July) have lavender petals with a long narrow base and an expanded, diamond-shaped tip that has a darker, purplish basal spot. (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to the foothills of the Sierra Nevada in a small area of Tulare County, California along the Tule River drainage. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 2009)

**Breeding Season**

Adult: May to July (NatureServe, 2015)

**Reproduction Narrative**

Adult: Clarkia springvillensis is a narrowly distributed annual in the evening primrose family (Onagraeae) and blooms from May to July. (USFWS, 2009)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest Edge, Forest/Woodland, Woodland - Hardwood (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Prefers sunny open sites (USFWS, 2009)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations between 330 and 1,220 m (1,080 to 4,000 feet) (USFWS, 2009)

**Spatial Arrangements of the Population**

Adult: Colonies (USFWS, 2009)

**Environmental Specificity**
Adult: Narrow (inferred from USFWS, 2009)

**Habitat Narrative**
Adult: Clarkia springvillensis grows mostly on the uphill slope of roadbanks, on small decomposing granitic domes, and in sunny openings from elevations between 330 and 1,220 meters (1,080 to 4,000 feet) within the blue oak woodland community. Clarkia springvillensis is found on granitic soils at sunny sites. Population surveys revealed 18 colonies in 2002 and 23 colonies in 2003. (USFWS, 2009)

***Dispersal/Migration***

**Dispersal/Migration Narrative**
Adult: Not available

***Population Information and Trends***

**Population Trends:**
Declining (USFWS, 2009)

**Number of Populations:**
27 Presumed Extant (USFWS, 2022)

**Population Size:**
1,016 (USFWS, 2022)

**Population Narrative:**
The California Department of Fish and Game (2001) characterized the species as a whole as declining in 1999. There are about 10 populations known extant (NatureServe, 2015). The population size of Clarkia springvillensis can vary enormously from one year to the next due to interactions between the soil seed bank and seasonal weather conditions. (USFWS, 2009). At the time of listing, there were 15 occurrences of Springville clarkia occupying 61 hectares (150 acres), which are now considered historical occurrences (Service 1998, p. 49023; Forest Service 2012, p. 10). At the time of our 2009 5-year review, there were 17 presumed extant occurrences (Service 2009, p. 3). New occurrences of Springville clarkia have been added to the Diversity Database since the previous status review (Diversity Database 2021). These occurrences are likely due to increased survey efforts and do not change the overall distribution of the species. According to the Diversity Database (2021), there are currently 28 occurrences. The type locality is possibly extirpated, while the other 27 occurrences are presumed extant (Diversity Database 2021). Of the extant occurrences, nine occurrences have not been surveyed since before 2000 (Diversity Database 2021). Collected specimen from Diversity Database occurrences #29 and #30 are thought to be an atypical outcrossing form of Kern River clarkia (Clarkia exilis) (U.S. Army Corps of Engineers 2021, p. 45). However, further field work is needed to confirm (Diversity Database 2021). See Appendix Table 1 for further details on Diversity Database occurrences (note: table includes all occurrences recorded as Springville clarkia in the Diversity Database, including occurrences that need further expert verification on species identity) USFWS, 2011).

Abundance: Abundance of Springville clarkia varies across colonies and across years (Diversity Database 2021). Recorded abundance data includes extremes of single plants to hundreds of thousands of plants (Diversity Database 2021). As is common in annual plants, the aboveground population size of Springville clarkia drastically fluctuates from year to year (Service 2009, p. 5). The number of plants depends on interactions between the soil seed bank and weather (Forest Service 2012, p. 12). Rainfall patterns may be the most important factor for determining abundance in the following year (Forest Service 2012, p. 12). For example, as discussed in the previous status review, a comprehensive multiyear study of Springville clarkia as part of Southern California Edison's Lower Tule River Hydroelectric Project documented this drastic change in abundance in the project area (Service 2005, p. 4). The project area overlaps with the Siphon Canyon–Coffee Canyon area in the Middle Fork of the Tule River watershed. Survey data from 2002 to 2005 revealed that the area's abundance fluctuated between 2,500, 4,880, 1,800, and 10,000 individuals, with high and low numbers corresponding to wetter and drier years, respectively (Service 2005, pp. 8–9). Surveys estimate 3,055–3,315 individuals within the area in 2016 (Cardno, Inc. & Stebbins 2016, p. 3-2–3-3. The most recently available survey data estimates 1,016 individuals within the area in 2021, representing the low in the 2017–2021 reporting period (Cardno, Inc. & Colgate 2021, p. 3-4). The highest abundance surveyed during this period was 7,590 individuals in 2019 (Cardno, Inc. & Colgate 2021, p. 3-4). While abundance continues to fluctuate in this area, the changes do not as closely correspond with annual precipitation as previously reported (Cardno, Inc. & Colgate 2021, pp. 3-4–4-1). Botanists hypothesized that the Pier Fire in 2017 created unsuitable microhabitat conditions and/or precipitation patterns were unfavorable for the species (Cardno, Inc. & Colgate 2021, p. 3-4) (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Residential development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Prior to listing, residential development affected Clarkia springvillensis at two sites. Element Occurrence 5 was damaged, but not destroyed, when an access road, building pad, and well were constructed in the midst of the C. springvillensis population (Ashford 1989) for a home that was never built. Mobile home development contributed to the extirpation of Element Occurrence 1. No mobile homes are currently located at that site, but road construction, maintenance and improvement associated with the former residences are believed to be responsible for its disappearance (J. Stebbins, pers. comm. 2001, J. Stebbins in litt. 2002; CNDDB 2009). (USFWS, 2009)

**Stressor:** Road maintenance (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road maintenance and improvements have affected Clarkia springvillensis on steep banks near roadways to some extent (Stebbins 1991, J. Stebbins, in litt. 2002; CNDDB 2009). Road maintenance is still a threat at five occurrences in Clarkia springvillensis habitat. The dirt along which it grows are maintained either by Tulare County, Pacific Gas and Electric, or Souther California Edison. Road maintenance includes activities such as mowing, grading, spraying

herbicide, mechanically removing brush, and clearing culverts (USFS 1996), whereas road improvements are activities such as widening or straightening roads, or installing culverts (USFWS, 2009)

**Stressor:** Livestock grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The apparent decline of Clarkia springvillensis is likely due to a complex combination of inappropriate livestock (J. Shevock, USFS, in litt. 1985; Stebbins 1991; Hansen 1992; USFS; 1996), competition from nonnative plants (McCue et al. 1996), and altered fire regimes (McCue et al. 1996; S. Carter, pers. comm. 2001, J. Stebbins, in litt. 2002). Inappropriate grazing practices that apparently contributed to the decline of C. springvillensis included (1) repeated consumption of the same plants in a single growing season; (2) grazing late in the season (May or later) so C. springvillensis plants did not have time to send up new shoots or set seed before dying back (McCue 1997; J. Stebbins, pers. comm. 2001); and (3) livestock spending long periods in one area, which caused direct trampling of plants, soil compaction, and surface disturbance (Hansen 1992). Concern over grazing peaked in the 1980s, and several occurrences were then fenced to exclude livestock (Stebbins 1991). (USFWS, 2009)

**Stressor:** Random demographic, environmental or genetic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The combination of small range and restricted habitat still renders Clarkia springvillensis susceptible to extirpation due to random events such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006). Demographic events that may put small populations at risk involve random fluctuations in survival and reproduction of individuals (Shaffer 1981, 1987; Lande 1998; Groom et al. 2006). Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991, Ellstrand and Elam 1993). Populations that are continually small in size are particulary susceptible to genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes. Increased homozygosity resulting from genetic drift and inbreeding in small populations may lead to a loss of fitness. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993). Clarkia springvillensis has small population size for at least five occurrences, therefore, it also is susceptible to extirpation due to demographic events, genetic drift, and inbreeding. (USFWS, 2009)

**Stressor:** Competition with nonnative plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative plants, especially Bromus grass species (brome), may have contributed to the decline of Clarkia springvillensis by competing directly for moisture and nutrients (J. Stebbins in litt. 2002). Dead stems of nonnative grasses create a build-up thatch that may have prevented C. springvillensis from becoming established in openings, thereby isolating populations (McCure et al. 1996; J. Stebbins, pers. comm. 2001). Prolonged grazing may have exacerbated these

problems because soil disturbance favors some nonnative plants over native species (Hansen 1992). A related problem is that the stems and thatch of nonnative plants contribute to an increased fire frequency. Conversely, fire suppression activities may have inadvertently contributed to the decline of Clarkia springvillensis by allowing encroachment of shrubs and trees into the openings where it grows (McCue et al. 1996; S. Carter, pers. comm. 2001, J. Stebbins in litt. 2002). (USFWS, 2009)

**Stressor:** Global climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts to Clarkia springvillensis under predicted future climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease the snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and how soon climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by drought and fire. (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 8

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Recovery actions are not available.
- Complete and published the draft recovery plan, and approve a final recovery plan (USFWS, 2009)
- Establish reliable baseline data for monitoring plant occurrences. Monitor the status and trend of Clarkia springvillensis in order to estimate current population sizes, the number and distribution of populations, the threats to each occurrence, and whether the species is stable, increasing, or declining. (USFWS, 2009)
- Work with the Forest Service, Bureau of Land Management, and California Department of Fish and Game to conduct research on a) the value of prescribed burning and mechanical brush removal; and b) study the effects of livestock grazing on Clarkia springvillensis. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Springville clarkia. Some of these recommendations have already been discussed in the previous status review (Service 2009, pp. 13–14) and remain valid. 1. Verify Springville clarkia occurrences recorded in the California Natural Diversity Database, especially occurrences with a currently unknown status

and/or that have not been surveyed in the previous ten years. 2. Conduct further research on Springville clarkia’s reproduction parameters (e.g., seed production rate, germination rate) and their relationship to environmental conditions to better understand population dynamics and effective population size. 3. Establish reliable baseline data for monitoring Springville clarkia occurrences, including both aboveground presence and soil seed bank. Work with the U.S. Forest Service and other landowners/managers to monitor the status and trend of occurrences to (a) track any threats, (b) estimate current colony/population sizes and the number and distribution of colonies/populations, and (c) determine whether the species is stable, increasing, or declining. Annual precipitation and monitoring data should be compared to assess the impact of drought on population changes, as this may be the most significant threat to the species. 4. Conduct genetic and ecological studies to gain a better understanding of the potential for hybridization between Springville clarkia and other clarkia species, such as elegant clarkia (Clarkia unguiculata). Create a species identification key based on genetic and morphological relationships. This information can then be used to help determine the status of California Natural Diversity Database occurrences with an uncertain identification. 5. Conduct further research on the effect of disturbance on Springville clarkia. Work with the U.S. Forest Service, Bureau of Land Management, and California Department of Fish and Wildlife to conduct research on (a) the value of prescribed burning and mechanical brush removal and (b) the effects of livestock grazing on Springville clarkia. 6. Provide support to the Tule River Indian Tribe of California to implement conservation actions for Springville clarkia on the Tule River Reservation. The Tribe plans to implement several conservation measures to protect occurrences on the Reservation and intends to survey for new colonies should any activities occur in suitable habitat. 7. Complete a recovery plan for Springville clarkia. The plan would establish a framework for agencies and landowners to coordinate conservation efforts. The plan would set recovery priorities and estimate costs of various tasks necessary to accomplish them. It also would describe site-specific management actions necessary to achieve conservation and survival of the Springville clarkia (USFWS, 2022).

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# SPECIES ACCOUNT: *Clematis socialis* (Alabama leather flower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/27/1986; Southeast Region (R4)

**Physical Description**

A member of the family Ranunculaceae. The most distinctive features are its rhizomatous habit and formation of dense clones with erect stems reaching 0.2-0.3 meters(in) or 7-12 inches (in.) in height. The leaves are variable from the base to the apex of the stem. The lowermost leaves are scalelike, oblong or triangular in shape and mostly under 1 centimeter (cm) (0.39 in.) long; median leaves are simple, mostly elliptic-linear in shape, 4-12 cm (1.6-4.7 in.) long, and 0.5-1.0 cm (0.20-0.39 in.) wide; upper leaves are 3 to 5 foliolate and shaped as in median leaves. The flowers are solitary at the tips of slender stems, urn to bell-shaped, 2-3 cm (0.79-1.18 in.) long, and blue-violet in color. The fruits are aggregates of achenes which are densely pubescent and 2.5-3.0 cm (0.98-1.18 in.) in length (Figure 1). Clematis socialis, a member of the Viorna section of Clematis, superficially resembles the more widespread C. crisna but is distinguished by its erect stems, rhizomatous nature, solitary flowers and lack of tendrils (Kral 1982, 1983). (USFWS, 1989)

**Taxonomy**

Described as a new species in 1982 by Dr. Robert Kral. (USFWS, 1989)

**Historical Range**

The Alabama leather flower was known from only two sites, one each in St. Clair and Cherokee counties, Alabama, at the time of listing in 1986. (USFWS, 2010)

**Current Range**

St. Clair County (3 populations) , Cherokee County (two populations), and Etowah County (1 population), Alabama.  Floyd County, Georgia (two populations). (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Clonal, sexual (USFWS, 2010)

**Dependency on Other Individuals or Species**

Adult: Bombus pennsylvanicus and Anthophora ursina (USFWS, 2010)

**Breeding Season**

Adult: March - June (USFWS, 2010)

**Other Reproductive Information**

Adult: Genetic sampling of populations in Alabama by Goertzen et al. (2011) revealed that individual genets (genetically distinct individuals) of Alabama leather flower can be quite large, spreading to at least 36 feet (ft.) (11 meters [m]) via underground rhizomes. The authors note that these genets may span greater distances than their sampling scheme detected. These data, coupled with earlier estimates that Alabama leather flower's rhizomes grow approximately 4 inches (10 centimeters [cm]) per year (Goertzen and Boyd 2007), indicate that the species is relatively long-lived and capable of living for at least 55 years. (USFWS, 2017)

**Reproduction Narrative**

Adult: Flowering occurs March to June. Fruit development begins in June; seeds mature by late July through early August and seeds have senesced by late August. Pollinators include queen bumblebee (Bombus pennsylvanicus), bee (Anthophora ursina); pollination not required for production of seeds, but seed production increases with pollination. Anthophora is a more productive pollinator than Bombus (EPA, 2016). Plants are believed to reproduce primarily by forking and spreading rhizomes which form dense clones (Kral 1982, Garrett 2004). Timmerman-Erskine and Boyd (1999) suggested that sexual reproduction in this species was limited by a combination of pollinator frequency, herbivory, low light levels, and post-maturation achene predation by mice. The level of genetic diversity in the Alabama leather flower is higher than average for rare species and surprising given that it is a narrow endemic with a clonal nature, thus suggesting that considerable sexual reproduction has likely occurred in these populations despite low observed seedling recruitment (Boyd et al. 1998, Goertzen and Boyd 2007) (USFWS, 2010).

**Habitat Type**

Adult: Terrestrial, palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Herbaceous wetland, riparian, forest, grassland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fires (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped, scattered (USFWS, 2010)

**Environmental Specificity**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Silt and clay of alluvial, grass-sedge openings along a highway right-of-way, extending into the adjacent hardwood edge. Associated members of the grass-sedge community prior to logging included: Scarpus lineatus, S. atrovireus, Fimbristylis puberula, and Rhynchospora caduca; several andropogons, such as A. gerardi and A. scoparius; patches of Allium and Sysyrinchium were noted, in addition to violets and composites. The woodland overstory prior to logging (Kral, 1982) was composed of lowland oaks, hickories, white and green ash, sweet gum, black gum, persimmon, and red maple. The understory included flowering dogwood, swamp cornel, sassafras, buckthorn, elderberry, viburnums, honeysuckle, and blackberry. Many of these species have been documented as components of the climax vegetation usually associated with southeastern loblolly pine forests. These forests experience natural fires approximately every ten years (Wright and Bailey, 1982). It has a moderate environmental specificity (NatureServe, 2015). Open grass-seed-rush prairie areas and adjoining hardwood swamp forests. Soil types are Conawauga and Firestone formations (developed from weather shale, are acidic, low fertility, and poor in organic material); Tupelo series with Dowellton series inclusions (calcareous flatwood communities growing on circum-neutral soils) (EPA, 2016). The Alabama leather flower is found occurring in tight patches or sparsely scattered (Goertzen and Boyd 2007). Though plants are found in sunny and shaded conditions, they are more vigorous in full or partial sunlight where plant competition is low (Emanuel 2000, 2002; Garrett 2004, 2005; Garrett and Schotz 2005; Sherbundy and Martin 2007) (USFWS, 2010).

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown

**Dispersal/Migration Narrative**

Adult: Dispersal mechanisms are unknown.

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Stable (USFWS, 2017)

**Number of Populations:**

6 extant natural pops in Alabama. 2 populations in Georgia, 1 Natural with transplants augmented and 1 transplanted (USFWS, 2022)

**Population Size:**

Approximately 13,000 - 18,000 stems across extant populations (USFWS, 2017)

**Additional Population-level Information:**

Because of the clonal nature of Alabama leather flower, individual populations can be thought of in terms of both genetically distinct individuals (genets) and clones (ramets). Genets are often composed of numerous ramets (clonal stems). As such, population assessments using numbers of stems alone can easily overestimate the actual population in terms of genets (Tepedino 2012). With respect to Alabama leather flower clonality, as noted above, genets have been documented to be at least 36 ft. (11 m) long (Goertzen et al. 2011). It is unknown how large individual Alabama leather flower genets can grow or how many ramets a given genet may produce. Similarly, no known study has attempted to characterize the number of genets found in an entire population of Alabama leather flower, let alone all populations of the species. In addition, ramets from individual genets grow intermixed with each other (Service 1989), further complicating population estimates using aboveground stem counts. Given these challenges, stem counts/estimates can be considered to represent maximum ramet population sizes, but are likely to overestimate the actual genet population size. (USFWS, 2017)

**Population Narrative:**

Alabama leather flower's known range has expanded from two Alabama counties (St. Clair and Etowah) at the time of listing (see Service 1986) and completion of the recovery plan (see Service 1989). Currently, the species is known from eight natural populations—six extant, one extirpated, and one uncertain (likely extirpated)—in northeastern Alabama's Cherokee, Etowah, and St. Clair Counties and northwestern Georgia's Floyd County . The species' entire known range spans less than 90 miles (145 kilometers [km]), with individual populations typically separated by 30 or more miles (48 km) from their nearest neighbors. All known populations occur within the Valley and Ridge physiographic province. (USFWS, 2017). Limited new information on Alabama leather flower populations is available. Of note, two of Alabama's populations, both in Cherokee County, are extirpated (Service 2017, Byrd 2020) and three of the species' six extant populations are considered large (≥1,000 plants). No new information is available for either of Georgia's populations (including one natural population and one transplanted population) (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat for this species has been reduced through development and conversion to agriculture and pine plantations. Logging operations have degraded the habitat at two sites in Alabama (ANHP data, Byrd 2016c). The use of heavy equipment has adversely impacted these sites by creating ruts and promoting erosion, and has destroyed several plants. In addition, soil disturbance has fostered invasion by exotic and weedy species, further reducing habitat integrity and species viability. One population, in Cherokee County, Alabama, has been repeatedly impacted by disking for row-crop agriculture and has recently been extirpated by conversion to a soybean field (Schotz pers. comm. 2014, Byrd 2016c). One subpopulation in St. Clair County, Alabama was damaged by silt fencing installation for road improvement work (Byrd 2016c). Road improvements (e.g., widening, repaving) could jeopardize the continued viability of plants in adjacent rights-of-way if such activities are not conducted in an appropriate manner and coordinated with the Service. Rutting by ATVs and mowing equipment also pose threats to plants in rights-of-way (Emanuel 2000, Byrd 2016c). Development, particularly for residential purposes, has been identified as a significant threat to at-risk species associated with privately owned forested lands (Stein et al. 2010), such as Alabama leather flower. Within the southeastern United States, the urban footprint has been projected to more than double by 2060 compared with 2009 (Terando et al. 2014), thus putting further development pressure on Alabama leather flower and its habitats. Development and associated land use changes on unprotected sites could negatively impact or destroy populations if precautions are not taken. (USFWS, 2017)

**Stressor:** Small, isolated populations (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A number of the populations remain vulnerable due to the small number of plants and the limited area they occupy. Three of the populations occupy no more than an acre in area and

one of these consists of only 2 plants occupying a 15 m2 area (Martin 2008, 2009).

**Stressor:** Disease or predation (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Disease and predation are not known to threaten Alabama leather flower. Herbivore browsing damage has been observed in Georgia and fencing has been erected to deter herbivores around some plants (von Schmeling pers. comm. 2016). Accounts of such herbivore damage to Alabama leather flower are rare, indicating that this may be a localized rather than widespread phenomenon. One study identified a species of carpenter bee, Xylocopa virginiana, exhibiting nectar-robbing behavior on Alabama leather flower (Boyd and Wall 1998, Wall et al. 2003); however, the authors noted that given the apparently low visitation rates of this nectar-robbing bee, its effects on Alabama leather flower reproduction is likely small. It has also been suggested that deer mice (Peromyscus sp.) may be seed predators of Alabama leather flower (Timmerman-Erskine and Boyd 1999), which may potentially limit seedling recruitment. However, given the species' clonal nature (i.e., its ability to spread locally without seedling recruitment), it is unlikely that seed predation by deer mice alone presents a substantial threat to Alabama leather flower. Furthermore, as noted by Goertzen et al. (2011), Alabama leather flower's relatively high genetic diversity indicates that sufficient sexual reproduction is occurring within the species, despite low apparent seedling recruitment. (USFWS, 2017)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** No State laws in Alabama protect Alabama leather flower and its habitat. In Georgia, the species is State protected as endangered under the Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. This law authorizes rules for the collection, transport, sale, and listing of protected plants within the State. In addition, no protected plants may be collected without landowner approval and no transport within the state is allowed without a State-issued permit (Patrick et al. 1995). Otherwise, protections are afforded to this species under sections 7 and 9 of the ESA. Two populations are considered protected from outright habitat destruction or adverse habitat modification due to their protection on a TNC preserve (in Alabama) and on lands set aside as a state Natural Area by the State of Georgia (in Georgia). In Georgia, state-designated Natural Areas are managed by GDNR to conserve natural communities and rare species (GDNR 2017). In addition, part of one population has received some habitat protection and management by the City of Gadsden, Alabama.(USFWS, 2017)

**Stressor:** Inadequate/Incompatible Habitat Management (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Inadequate management—e.g., lack of mowing, prescribed fire, and/or hand clearing—remains a persistent concern for Alabama leather flower populations. At least one subpopulation in St. Clair County, Alabama has not been relocated, in part, due to growth of encroaching plants (Byrd 2016c), which has obscured plants and/or suppressed their growth. Plants at this site have not been observed since 2009 and it is unknown if they still exist. Three

other subpopulations in St. Clair and Cherokee Counties are in need of management activities to reduce competing understory and woody vegetation (Wiggers 2014, Byrd 2016c). (USFWS, 2017)

**Stressor:** Competition from Encroaching Species (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Alabama leather flower is an apparently poor competitor, as it is most vigorous in open areas with little competing vegetation and open canopies. Indeed, low light levels have been associated with increased flower abortion (Timmerman-Erskine and Boyd 1999). The species also benefits from occasional, limited disturbance (such as periodic mowing or prescribed fire) which reduces encroachment of competing vegetation. However, Alabama leather flower can apparently remain dormant for some time as evidenced by its appearance in openings created in woods that were selectively logged (Service 1989). Even though the increased light initially benefited Alabama leather flower, it also stimulated more aggressive competing vegetation including the exotic Japanese honeysuckle (Lonicera japonica). All populations of Alabama leather flower need active management (e.g., thinning overstory trees, mowing, prescribed fire) due to shading and competition from more aggressive vegetation. (USFWS, 2017)

**Stressor:** Small Population Size and Small Number of Populations (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Attempts to locate additional Alabama leather flower populations since completion of the species' original Recovery Plan in 1989 (e.g., Boyd 1991, Boyd and Hilton 1992, Govus 1999, Ware 1999, Garrett and Schotz 2005) have had some success thus far, with eight natural populations now known for the species. Of these populations six are extant (ANHP data, GNHP data, Byrd 2016c, Byrd pers. comm. 2016a, b, Thompson 2016), one may have been extirpated (Schotz pers. comm. 2014, Byrd 2016c), and one has been extirpated (Schotz pers. comm. 2014). Only three populations are considered to be large (1,000+ stems), while two are of moderate size (400–500 stems) (GNHP data, Wiggers 2014, Byrd 2016c). Alabama leather flower's limited number of extant populations and relatively small local population sizes increase the species' vulnerability to anthropogenic and environmental perturbations. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). However, the unexpectedly high level of genetic diversity maintained within Alabama leather flower populations studied thus far (Boyd et al. 1998, Goertzen and Boyd 2007, Goertzen et al. 2011), may limit some of the genetic threats posed by the species small number of populations and overall small population size. Attempts to augment existing and establish new populations have been made in Georgia, but these efforts have had limited success (GNHP data, CNC 2010, Hodges pers. comm. 2013, 2014, von Schmeling pers. comm. 2016). As such, the one known established population is not yet considered a viable population for recovery. (USFWS, 2017)

**Stressor:** Climate Change (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) and reduced average annual precipitation by the end of the century (Joyce et al. 2011, Ingram et al. 2013). Specific effects of climate change on populations of Alabama leather flower are poorly understood; however, a variety of effects are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Alabama leather flower may be negatively impacted by climate change within Alabama if available habitat becomes constricted under drier conditions. In addition, climate change may disrupt plantpollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Alabama leather flower. Given that only two primary pollinators have been identified for Alabama leather flower, Wall et al. (2003) suggested that such asynchrony between flowering and pollinator activity may be particularly severe for this species. Given the variety and complexity of climate change's potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Alabama leather flower populations and habitats. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
When 10 geographically distinct, self-sustaining populations, occupying a minimum of one acre of habitat each, are known and protected from any foreseeable threats. (USFWS, 1989)

Recovery Priority Number: 5

**Delisting Criteria:**
When 20 geographically distinct, self-sustaining populations, occupying a minimum of one acre of habitat each, are known and protected from any foreseeable threats. (USFWS, 1989)

**Recovery Actions:**

- 1. Protect and manage populations and habitat. The first step in the recovery process is to protect the populations and their habitat. Protection efforts, excluding Section 7 obligations, may include land donations, conservation easements, long-term conservation agreements, land acquisition or other methods. (USFWS, 1989)
- 2. Establish a monitoring program for protected sites. A monitoring program should be established on protected sites in order to track population trends and evaluate effectiveness of recovery efforts. (USFWS, 1989)
- 3. Study ecology and species' biology. An understanding of the ecology and species' biology of the Alabama leather flower is necessary in order to appropriately manage and protect this species. (USFWS, 1989)
- 4. Determine effective management for maintaining or increasing populations. Management needs of the Alabama leather flower are largely unknown; however, this species appears more vigorous in areas of partial or full sunlight with little competition. In order to maintain or expand populations, active management of its habitat, targeted at controlling competing vegetation, will probably be necessary. Management is further necessitated due to the disturbed nature of the present sites. (USFWS, 1989)

- 5. Preserve genetic stock. This species is extremely vulnerable due to such few populations. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation. Additionally, this will provide material for research, propagation, and horticultural interests to reduce pressure on wild populations and other recovery activities. Such activities should be conducted under the guidance of the Center for Plant Conservation which sponsors the establishment of garden populations of endangered plants at member botanical gardens. (USFWS, 1989)
- 6. Establish experimental population(s) within historic range. if deemed necessary. Clematis socialis is only known from two sites and only one is protected. If after extensive surveys, no new populations are located and secured, it may be necessary to establish additional ones in the wild to decrease this species vulnerability. (USFWS, 1989)
- Recommendations for Future Actions from 2017 5-Year Review: - Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations,including the development and implementation of management plans. - Conduct surveys to locate additional populations. - Conduct studies to determine the number and distribution of populations required to maintain the species’ genetic diversity. - Conduct studies into the species’ life history, biology, habitat, and ecology to inform future population searches, management, and potential population augmentation and (re)establishment efforts. - Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. - Develop and implement long-term demographic monitoring to track population trends and evaluate management efforts. - Expand ex situ conservation efforts to include plants from all known extant populations. - Update the species’ recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The following actions are recommended to support and promote recovery of Alabama leather flower. Use of a numbered list for these recommendations is for convenient reference and does not necessarily imply prioritization of any activity over others. 1. Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans. 2. Conduct surveys to locate additional populations. 3. Conduct studies to determine the number and distribution of populations required to maintain the species’ genetic diversity. 4. Conduct studies into the species’ life history, biology, habitat, and ecology to inform future population searches, management, and potential population augmentation and (re)establishment efforts. 5. Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. 6. Expand ex situ (off-site) conservation efforts to include plants from all known extant populations. 7. Update the species’ recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management) (USFWS, 2022).

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# SPECIES ACCOUNT: *Clitoria fragrans* (Pigeon wings)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 5/27/1993; Southeast Region (R4)

**Physical Description**

Pigeon wings is a 15 to 100 cm tall herbaceous plant. Plants have a thick horizontal root, which may grow to more than 2 m long, and bear one to several erect, purplish, wiry, very straight stems. The somewhat leathery leaves consist of three leaflets. Leaflets of the upper leaves are obtuse at the tip and narrower than those of lower leaves. (Fantz 1977).Pigeon wings produce flowers aboveground (chasmogamous flowers) and underground (cleistogamous flowers). Aboveground flowers usually occur in pairs, each corolla consisting of one 3.5 to 5 cm-long standard petal and a small white keel. The common name of this species refers to the petals of the aboveground flowers, which resemble wings. The seed pod (legume) is 5 to 8 cm long and extends from the calyx (Fantz 1979). (USFWS, 1999)

**Taxonomy**

Clitoria fragrans was described and named from a Highlands County specimen in 1926 (Small 1926). The name C. pinetorum was recognized but never published (Fantz 1977). The North American Clitoria species were moved to the genus Martiusia by Small (1933), but were later transferred back to the genus Clitoria by Fantz (1977). This herb?s common name, pigeon wings, was derived because of its flowers? bird-like appearance (Fantz 1979). It is one of three species of the genus occurring in the southeastern United States. The others are the native butterfly pea (C. mariana) and a butterfly pea escaped from cultivation (C. ternata). (USFWS, 1999) The Integrated Taxonomic Information System (2024) uses the common names sweetscented pigeonwings and pigeon wings (Clitoria fragrans) and indicates that the taxonomy for the species is still valid. We are not aware of any changes to the taxonomy of this entity, and it is still considered valid by the Service. (USFWS, 2025)

**Historical Range**

In Florida, along the Lake Wales Ridge, primarily in Highlands, Orange, and Polk counties; in central Osceola County; near Leesburg IN Lake County. (USFWS, 1999)

**Current Range**

In Florida, along the Lake Wales Ridge, primarily in Highlands, Orange, and Polk counties (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated

**Lifespan**

Adult: > 5 years

**Breeding Season**

Adult: Chasmogamous flowers bloom from May to June.

**Reproduction Narrative**

Adult: Pigeon wings are long-lived (> 5 years) perennials. Flowers are pollinated by insects, while cleistogamous flowers are self-pollinating. Cross-fertilization of cleistogamous flowers is prevented, since the flowers do not open. Chasmogamous flowers bloom from May to June. Cleistogamous flowers occur later in the summer through late September. No information is available on the pollination vector, fertilization rate, seed production, or germination rates for this species.

**Habitat Type**

Adult: Xeric upland/sandhill and oak hickory scrub

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: SUMMARY: Widely scattered in undisturbed clearings of xeric sandhill and scrub communities on well-drained upland soils. END SUMMARY. Suzanne Cooper of the Florida Natural Areas Inventory (unpublished FNAI data) reports that C. fragrans is more commonly found in the sandhill or sandhill/scrub ecotones than in the scrub proper, which is contrary to published reports. Sandhill typically occurs on rolling hills of yellowish sand with a longleaf pine/turkey oak overstory (bluejack and/or sand live oak may also be dominant) and a ground cover of numerous herbs dominated by wiregrass. The white sand scrub is generally found with an overstory of scattered pines (sand, slash or longleaf), a middle layer of scrub oaks, several ericaceous shrub species and saw palmetto, and a thin layer of many herbaceous or dwarf shrub species (Duever 1983). Clitoria is typically found in undisturbed clearings in the scrub but also occurs in very open scrub as well (Kral 1983). (NatureServe, 2015). Pigeon wings occurs in a range of xeric upland habitats on the Lake Wales, Winter Haven, and Bombing Range Ridges and on xeric upland sites west of Bombing Range Ridge within APAFR. On the southern third of the LWR (i.e., the part within Highlands County), it occurs primarily in sandhill and oak-hickory scrub (Menges et al. 2007b). On APAFR, it occurs primarily in sandhill and oak scrub (S. Orzell, APAFR, pers. comm. 2008). Pigeon wings is a soil generalist, occurring on a yellow, white, and gray sands (Menges et al. 2007b; S. Orzell, pers. comm. 2008). Pigeon wings is a soil generalist, occurring on a yellow, white, and gray sands (Menges et al. 2007b; Orzell 2008, pers. comm.; Stout 2008a, pers. comm.), although mainly on yellow sands (Menges et al. 2019). It occurs in a range of xeric upland habitats on the Lake Wales, Winter Haven, and Bombing Range Ridges and on xeric upland sites west of Bombing Range Ridge within Avon Park Air Force Range. Generally, its habitats are sandhill, turkey oak barrens, and scrub (Menges et al. 2019). On the southern third of the Lake Wales Ridge (i.e., the part within Highlands County), it occurs primarily on yellow sands (e.g., Astatula, Paola, and Tavares) in sandhill and oak-hickory scrub, but also on moderately well-drained white sands (Archbold) and on gray sands (Satellite) (Menges et al. 2007a). On the Lake Wales Ridge in Polk and Lake Counties, it is also known from yellow, white, and gray sands. On Avon Park Air Force Range, it is recorded from four gray sand types

(Daytona, Narcoossee, Zolfo, and Duette), primarily in sandhill and oak scrub (Orzell 2008, pers. comm.; Stout 2008a, pers. comm.). Orzell reported a small population at Avon Park Air Force Range on Satellite soil (Stout 2008b, pers. comm.). (USFWS, 2025)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

63 extant populations (USFWS, 2025)

**Population Size:**

1000 - 2500 individuals (NatureServe, 2015)

**Population Narrative:**

Requires undisturbed soils and fire. Doesn't seem to return quickly to abandoned farmland or neglected orange groves. Never abundant at a given site Fifty nine Element Occurrences recorded by FNAI as per July 1995 (Gary Knight, pers. comm., July 17, 1995) (NatureServe, 2015). Data on population trends are not available for pigeon wings because monitoring programs at most sites do not involve repeated censuses of populations within well defined areas. However, the evidence that is available, usually based on short-term surveys of relatively few individuals, suggests substantial year to year fluctuations in aboveground population sizes. For example, annual monitoring of a small pigeon wings population (< 70 plants in all years surveyed) at ABS from 1992 to 2000 found annual survival rates ranging from 72 to 98 percent (C. Weekley, pers. comm. 2008). Over the nine years of the study, sexual reproduction was negligible and few seedlings were found (C. Weekley, pers. comm. 2008). The study also documented the presence of belowground dormancy in pigeon wings, with 14 percent of tagged plants re-appearing aboveground following a year or more in which they were absent. Stout et al. (2003) recorded an annual survival rate of 68% (28 of 43 plants) in one APAFR population tagged in 2002 and re-surveyed one year later. Weekley and Menges (2003) characterized pigeon wings as a moderate resprouter based on the percentage of tagged aboveground individuals present two years after a prescribed burn (48.4 percent). However, aboveground pigeon wings populations may fluctuate annually due to belowground dormancy (C. Weekley, pers. comm. 2008). Anecdotal evidence also indicates that dramatic increases in post-burn aboveground population sizes may be short lived (C. Weekley, pers. obs. 2008). Thus, population densities may increase post-fire and decline with time-since-fire. High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (C. Weekley, pers. obs. 2008). The FNAI identifies 77 occurrences of pigeon wings. Fifty-four (70.1 percent) of the occurrences are on protected sites on the Lake Wales (45) or Winter Haven Ridges (1), or on the APAFR (8). Of the 24 occurrences outside protected areas, all but two are on the LWR (one each on the Winter Haven and Mount Dora Ridges). Since most of these occurrence records are more than 20 years old, it is not known how many of the unprotected sites remain. Pigeon wings is currently known from 18 managed areas on the LWR: A. D. Broussard Catfish Creek Preserve State Park, ABS, Crooked Lake Sandhill, Jack Creek, LWRSF (Arbuckle, Hesperides, and Walk-in-Water Tracts), Lake Wales Ridge National Wildlife Refuge (Carter Creek South, Flamingo Villas), LWRWEA (Carter Creek North, Holmes Avenue, Lake Placid Scrub, Mountain Lake Cutoff, Royce Ranch, Silver Lake, and Sunray/Hickory Lake Tracts), Seminole State Forest (Warea Tract), and Tiger Creek Preserve. It is also protected at Lake Griffin State Park on the Sumter Upland, LWRWEA

(Lake Blue) on the Winter Haven Ridge, and at APAFR. EORs compiled by FNAI often have abundance estimates, although these are not standardized. Among the reports with pigeon wings abundance estimates, populations are rarely estimated as having 100–999 plants (4 EORs), while smaller populations of 10–99 plants (23) and less than 10 plants (18) are more typical (FNAI 2019). Abundance data based on counts or estimates are also available for three of the largest protected sites. At APAFR, Stout (pers. comm. 2008b) reported 2,951 plants, based on complete surveys of 59 soil polygons conducted between 2002 and 2006. Plants there were individually tagged and mapped with a GPS (Stout pers. comm. 2008c). At LWRSF, Malatesta (pers. comm. 2008) reported >1,800 plants in total throughout the Arbuckle, Walk-in-Water, and Hesperides tracts; however, the surveys were conducted over a period of three years and some populations may have been counted twice, thereby potentially inflating the final estimate. Finally, at the Tiger Creek Preserve, Pace-Aldana (pers. comm. 2008) estimated the pigeon wings population at >1,000 plants. These numbers, collected over large areas, generally provide estimates of the lower limits of population sizes at each of these three sites. Minimum abundance estimates are also available for several of the smaller sites, including Crooked Lake Sandhill (n ≥ 49; Pace-Aldana, pers. comm. 2008), the Warea Tract of Seminole State Forest (n = 43; Cox 2006), and the Carter Creek North (n = 15), Silver Lake (n = 58), and Lake Blue (n = 19) tracts of the Lake Wales Ridge Wildlife and Environmental Area (LWRWEA) (Menges et al. 2007a; Weekley, pers. comm. 2008). Population trends - In a study of the postfire responses of 12 Florida scrub endemics, Weekley and Menges (2003) characterized pigeon wings as a moderate resprouter based on the percentage of tagged aboveground individuals present two years postburn (48.4 percent). However, aboveground pigeon wings populations may fluctuate annually due to belowground dormancy (Weekley, pers. comm. 2008). Populations tend to increase markedly and flower profusely following fire, but then decline with timesince-fire (Lewis 2007; Weekley, pers. obs. 2008; H. Rosner-Katz, Florida Department of Agriculture and Consumer Services [FDACS], pers. comm. 2019). High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (Weekley, pers. obs. 2008). (USFWS, 2020). Florida Natural Areas Inventory (2024) reported 63 extant populations (this excludes 10 historical, 1 possibly extirpated, and 2 extirpated occurrences) of pigeon wings; however, 24 (38 percent) of these populations have not been observed in over two decades. Pigeon wings occurs on protected lands at 53 (84 percent) of the reported populations. In comparison, the previous 5- year review (Service 2020) reported 45 extant populations (excluding 2 extirpated and 17 historical occurrences) all on protected lands. Florida Natural Areas Inventory (2024) also ranked the estimated viability of the reported populations based on size and condition of the population and the condition of the surrounding landscape. Of the 46 populations that were assigned a viability ranking, 38 (83 percent) had an estimated viability from fair to excellent. (USFWS, 2025)

***Threats and Stressors***

**Stressor:** Predation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Heavy vertebrate and invertebrate predation, including the destruction of entire seed crops or the complete removal of aboveground individuals, have been documented for pigeon wings (e.g., Stout and Lewis 2004; Lewis 2007; A. Faivre, pers. comm. 2008). Other likely invertebrate predators on pigeon wings include orthopterans and possibly seed predating

coleopterans. Vertebrate herbivores probably include white-tailed deer (Odocoileus virginianus) and eastern cottontail rabbits (Sylvilagus floridanus). Herbivory may threaten the persistence of local populations. The impact on pigeon wings plants of partial or complete defoliation is unknown.

**Stressor:** Inadequate fire frequency/management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Human development has disrupted the natural disturbance regime for pigeon wings. Because pigeon wings occurs in pyrogenic communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Some data (Weekley and Menges 2003, Lewis 2007) and anecdotal evidence (C. Weekley, pers. obs. 2008) suggest that aboveground populations decline with time-since-fire. Thus, inadequacies in existing prescribed fire programs or the use of mechanical methods such as mowing or gyro-tracking as a substitute or pre-treatment for fire may be adversely affecting the persistence of populations.

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pigeon wings is protected in 18 managed areas on LWR and in three managed areas off LWR. However, almost one-third (24 of 77) of the FNAI EORs are on unprotected sites. It is not known how many of these sites remain. Although unprotected populations at Avon Park Lakes were targeted for acquisition (Turner et al. 2006), the site is quickly being converted to residential development and the population will almost certainly be lost. Surveys of other unprotected FNAI EORs will be required to determine it they are still extant. (USFWS, 2008)

**Stressor:** Human development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Human development has disrupted the natural disturbance regime for pigeon wings. Because pigeon wings occurs in fire dependent communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Some data (Weekley and Menges 2003, Lewis 2007) and anecdotal evidence (C. Weekley, pers. obs. 2008) suggest that aboveground populations decline as the time-since-fire interval increases. Thus, inadequacies in existing prescribed fire programs or the use of mechanical methods such as mowing or gyro-tracking as a substitute or pretreatment for fire may be adversely affecting the persistence of populations. Observations by B. Blihovde at Lake Wales Ridge NWR suggest pigeon wings thrive in and around mechanically treated fire breaks. Data being generated by ABS's PDEP project aims to provide answers to some of these questions. In the meantime, development of science-based guidelines for the management of pigeon wings is precluded for lack of data.

***Recovery***

**Reclassification Criteria:**

Not relevant. (USFWS, 1999)

Recovery Priority Number: 14

**Delisting Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of C. fragrans, are adequately protected from habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the ecotone between xeric oak scrub and high pine that supports C. fragrans (USFWS, 1999)

4. When monitoring programs demonstrate that populations of C. fragrans on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

**Recovery Actions:**
- Determine current distribution of C. fragrans. Some portions of C. fragrans?s range have been well surveyed, yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of C. fragrans. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor populations of C. fragrans. Develop monitoring protocol to assess population trends for C. fragrans. Develop a quantitative description of the population structure of C. fragrans. (USFWS, 1999)
- Provide public information about C. fragrans. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where C. fragrans is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of C. fragrans and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions. Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Quantitative surveys (e.g., Weekley et al. 2001; Stout and Lewis 2006; Malatesta, pers. comm. 2008) of pigeon wings populations at several sites to establish the basis for level 2 monitoring (sensu Menges and Gordon 1996) to track changes in population size over time and in response to management treatments. These surveys should be repeated at defined intervals (e.g., annually, bi-annually, every five years; both before and after imposition of management treatments) and take place within well-defined areas (e.g., within plots small enough to be searched thoroughly and thereby reduce inconsistencies in sampling intensity). • Where monitoring is being conducted, data should be collected on fire and other management activities to aid in the interpretation of trends and to identify the most favorable treatments. • Conduct surveys to assess the status of the 19 FNAI EORs that occur on unprotected sites and to evaluate the feasibility of protecting additional pigeon wings populations. Any new populations discovered should be added to the FNAI database. • Demographic data need to be collected across the full geographic range of pigeon wings, from both scrub and high pine habitats, and from populations responding to contrasting management treatments (e.g., fire alone vs. various mechanical treatments being used as a substitute or pre-treatment to fire). Demography needs to be related to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness. • As we learn more about the fire requirements of pigeon wings, prescriptions should be adjusted to a frequency and intensity appropriate to avoid habitat degradation. • Study the seed production, seedling establishment, and seedling survival at various populations. • Study the floral biology, pollination ecology, and demography in detail throughout the species' range, including comparison of pollinator numbers to chasmogamous flowers at different populations. • Careful data collection is needed to further investigate plant dormancy, which may be an important trait allowing persistence at a site through unfavorable times. • The extent of invertebrate and vertebrate predation on pigeon wings needs to be quantified. • Genetic studies should be conducted to understand the genetic diversity of the species; this may aid in the identification of new acquisition needs. (USFWS, 2020)
- RECOMMENDED FUTURE ACTIVITIES • Quantitative surveys (e.g., Weekley et al. 2001; Stout and Lewis 2006; Malatesta 2008, pers. comm.) of pigeon wings populations at several sites to establish the basis for level 2 monitoring (sensu Menges and Gordon 1996) to track changes in population size over time and in response to management treatments. These surveys should be repeated at defined intervals (e.g., annually, bi-annually, every five years; both before and after imposition of management treatments) and take place within well-defined areas (e.g., within plots small enough to be searched thoroughly and thereby reduce inconsistencies in sampling intensity). • Where monitoring is being conducted, data should be collected on fire and other management activities to aid in the interpretation of trends and to identify the most favorable treatments. • Conduct surveys to assess the status of populations that occur on unprotected sites and to evaluate the feasibility of protecting additional pigeon wings populations. Any new populations discovered should be added to the Florida Natural Areas Inventory database. • Demographic data need to be collected across the full geographic range of pigeon wings, from both scrub and high pine habitats, and from populations responding to contrasting management treatments (e.g., fire alone vs. various mechanical treatments being used as a substitute or pre-treatment to fire). Demography needs to be related to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness. • As we learn more about the fire requirements of pigeon wings, prescriptions should be adjusted to a frequency and intensity appropriate to avoid habitat degradation. • Study the seed production, seedling establishment, and seedling survival at various populations. • Study the floral biology, pollination ecology, and demography in detail throughout the species' range, including

comparison of pollinator numbers to chasmogamous flowers at different populations. • Careful data collection is needed to further investigate plant dormancy, which may be an important trait allowing persistence at a site through unfavorable times. • The extent of invertebrate and vertebrate predation on pigeon wings needs to be quantified. • Genetic studies should be conducted to understand the genetic diversity of the species; this may aid in the identification of new acquisition needs. (USFWS, 2025)

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# SPECIES ACCOUNT: *Conradina brevifolia* (Short-leaved rosemary)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/11/1993; Southeast Region (R4)

**Physical Description**

The short-leaved rosemary (Conradina brevifolia) is a shortlived, erect, woody, perennial shrub that reaches about 1 m in height (Kral 1983). It is very similar to the relatively widespread, and quite variable C. canescens of the Florida panhandle, Alabama, and Mississippi, and it is similar to the endangered C. glabra of the Apalachicola bluffs (Gray 1965, FWS 1994). As its name implies, C. brevifolia's alternate leaves are shorter than C. canescens. The larger leaves on well-developed flowering branches are 6.0 to 8.2 mm long, and mostly shorter than the internodes, whereas C. canescens'leaves are 7 to 20 mm long and are mostly longer than the internodes. C. brevifolia also tends to have more flowers per axil than C. canescens: one to six per axil versus one to three in C. canescens. (USFWS, 1999)

**Taxonomy**

The short-leaved rosemary is one of five shrubby mints in the interior central Florida scrub. The others are Calamintha ashei, Dicerandra frutescens, D. christmanii, and a Dicerandra population whose taxonomic status is unresolved. C. brevifolia was described as a new species by Shinners (1962). Taxonomic reviews of Conradina have upheld C. brevifolia's treatment as a distinct species (Gray 1965, Wunderlin et al. 1980, Kral 1983, Kral and McCartney 1991). However, Wunderlin (1982) and DeLaney and Wunderlin (1989) included C. brevifolia in C. canescens, without noting C. brevifolia as a synonym. Gray (1965) showed that C. brevifolia, like C. glabra, is morphologically not strongly differentiated from, and is less variable than, C. canescens. (USFWS, 1999)

**Historical Range**

Not Available

**Current Range**

Lake Wales Ridge in Polk and Highlands counties, Florida (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Sexual

**Reproduction Narrative**

<u>Adult:</u> We have no species-specific data on the reproductive biology of C. brevifolia. In fire-dependent scrub habitat, most plants respond to fire by sprouting while a few recruit from seed that is stored in the sand (Johnson and Abrahamson 1990). Anecdotal information suggests that

C. brevifolia does not persist when burned, clipped, or defoliated (FWS 1996). If this is true, sprouting and other forms of asexual reproduction are unlikely. (USFWS, 2019)

**Habitat Type**

Adult: white sands/scrub

**Environmental Specificity**

Adult: Very narrow to narrow. (Natureserve, 2015)

**Habitat Narrative**

Adult: Conradina brevifolia inhabits white sand scrub with a scattered overstory of sand pine (Pinus clausa), interspersed with evergreen scrub oaks (Quercus spp.). C. brevifolia is usually found interspersed in clearings with other small shrubs and herbs (FWS 1992). Like all other xeric scrub communities, oak scrub is a fire-dependent vegetative complex that persists when burned at intervals of 10 to 20 years. In the slower-growing oak scrub of Florida's ridges, including Highlands and Polk counties, fire frequencies of 15 to 20 years are sufficient to maintain the vegetative diversity of the scrub habitats. (USFWS, 1999)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

21 (USFWS, 2021)

**Population Size:**

1000 - 2500 individuals (NatureServe, 2015)

**Population Narrative:**

The FNAI 2015 Element Tracking Summary (FNAI 2015), identifies 28 occurrences, 15 of which are on 7 different managed areas that are presumed or known to be extant. The other 13 occurrences were located on private lands. This represents roughly a 20 percent decline from the last 5-year status review, which reported 35 known occurrences (Service 2008c). The current status of occurrences and trends of short-leaved rosemary on private lands is unknown. (USFWS, 2019) . Short-leaved rosemary is a perennial herb occurring in rosemary scrub and related scrub ecosystems in Highlands and Polk Counties on the central portion of the LWR. It is restricted to a small portion of this range and does not occupy all available habitat, possibly due to fire suppression and inherit limitation to dispersal (Weekley et al. 2008). FNAI data (2021) show that there are only 21 populations and that one-third are unprotected. Short-leaved rosemary usually responds favorably to fire, often with strong population growth, but the duration of that population growth may be limited. Lack of frequent fire in both managed and unmanaged sites is the main threat to this pyrogenic species, although invasive species could also be an important threat at some locations. There has been little intensive monitoring of short-leaved rosemary, and therefore, not enough data exist to evaluate species viability in a substantive manner or determine long-term population trends. In addition, compared to many LWR endemic plants, relatively little is known about the basic biology of short-leaved rosemary, making it difficult to target for land management and other conservation measures. Threats from habitat loss due to development and climate change factors are expected to continue. For these reasons, shortleaved rosemary continues to meet the definition of endangered under the ESA. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have

become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of C. brevifolia, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain sand pine scrub (USFWS, 1999)

4. When monitoring demonstrates that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Recovery Priority Number: 8C

**Delisting Criteria:**

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary and yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**

- Determine current distribution of C. brevifolia. Some portions of C. brevifolia's range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases,

isolated. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Conduct research on life history characteristics of C. brevifolia. Little is known of the basic biology and ecology of this species. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor populations of C. brevifolia. Develop monitoring protocol to assess population trends for C. brevifolia. Develop a quantitative description of the population structure of C. brevifolia. (USFWS, 1999)
- Conduct research on life history characteristics of C. brevifolia. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit, since the recovery of C. brevifolia and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Acquire private sites with existing populations and/or implement conservation actions on private sites with existing populations. • Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support short-leaved rosemary. Monitoring/Research Activities • Conduct field surveys of occurrences, including Level 2 (population sizes) (as recommended by Menges et al. 2019) and Level 3 monitoring, throughout short-leaved rosemary’s geographic range, including sites across a spectrum of time-since-fire and management regimes • Monitor this species’ responses to management actions on conservation lands. • Conduct basic and applied research on the biology and ecology of short-leaved rosemary, including responses to management, propagation techniques, and germplasm storage. • Strengthen ex situ conservation measures, including ensuring representation of shortleaved rosemary at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. (USFWS, 2021)

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# SPECIES ACCOUNT: *Conradina etonia* (Etonia rosemary)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/11/1993; Southeast Region (R4)

**Physical Description**

A perennial, aromatic shrub, reaching 1.5 m tall, with slender, arching branches. Leaves are 1.5-3 centimeters long with rolled margins. Both sides of the leaves are hairy; mid-rib and veins are strongly raised on the lower surface. Flowers appear in clusters of 3-7 bent flowers, lavender in color, the lip marked with streaks and dots. (NatureServe, 2015)

**Taxonomy**

Conradina etonia could be the best marked species in a genus whose species differ mostly in very fine characters (Kral and McCartney, 1991). (NatureServe, 2015)

**Historical Range**

It is known from only two sites near Etonia Creek, northeast of Florahome, Putnam County, Florida (USFWS, 1994).

**Current Range**

Occurs at six sites near Etonia Creek, northeast of Florahome, Putnam County, northeastern Florida. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Spring - fall (USFWS, 1994)

**Reproduction Narrative**

Adult: Flowering occurs from early spring to late fall (USFWS, 1994).

**Habitat Type**

Adult: Terrestrial (USFWS, 1993)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest, savanna, shrubland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Excessive shade (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: It occurs in Florida scrub vegetation with sand pine and shrubby evergreen oaks. Scrub in this area is the northeastern range limit for several plant species of Florida scrub, including silk bay [Persea humilis), sand holly [Ilex cumulicola), Garberia heterophylla, and the scrub palmetto [Sabal etonia), which is named for this area but does not occur in the immediate vicinity of Conradina etonia (Krai and McCartney 1991; S. Christman, Florida Dept, of Natural Resources, pers. comm., 1991). (USFWS, 1993)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal mechanisms are unknown (EPA, 2016).

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2019)

**Number of Populations:**

3 (USFWS, 2024)

**Population Size:**

>3,000 (USFWS, 2024)

**Population Narrative:**

All presently known individuals occur within 6 km of each other with a contiguous landscape of xeric uplands (Figure 1). The known populations are approximately 1,500 m away from each other, meeting the definition of separate populations by NatureServe (2004), where occurrences greater than 1 km from each other are considered different populations. It is likely that increased survey efforts have led to the discovery a new population (i.e., the Florida Trail population) and additional plants. Increased management has also likely increased the number of plants within populations. These efforts have increased the number of plants from 1,475 in 2018 and peaked in 2021 at 3,232. Most of the increase in population is from the Big Scrub population, which has increased in population three-fold since 2018. The entire plant count has remained above 3,000 over the past three years (Figure 2). Management actions within Etoniah State Forest, such as prescribed fire, site preparation for planting trees, and herbicide treatments, have been effective in increasing the number of plants by recruiting seedlings. Additional details about each known population are described below (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat loss and degradation (Factor A)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Development has and continues to be the primary threat to C. etonia. In 1991, there were only two known populations; both on what were then private lands (USFWS 1994). These private lands were platted and planned for development. In 1993, the State of Florida purchased much of these lands as the Etoniah Creek State Forest (ECSF), and surveys found additional populations of C. etonia in areas that are now protected. Within ECSF, there is still a large population located mostly on privately owned lots (Garden Drive/Blossom Street population). ECSF has purchased several of these lots and plans to continue to acquire additional property as funds become available. (USFWS, 2019)

**Stressor:** Hurricanes (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In 2004, hurricanes impacted populations at ECSF and DCSP by blowing over sand pines and crushing plants in areas occupied by C. etonia. At DCSP, four of the historic sites of C. etonia could not be located since the area was covered with downed sand pines (Herring 2004). ECSF also had areas where the presence of downed sand pines made it difficult to access known sites of C. etonia. During the 2004 surveys at ECSF, it was determined that the number of plants did decrease after the hurricanes. However, since then surveys at ECSF and DCSP have shown an increase in the number of plants. The increase in plants is most likely due to more intensive surveys of additional areas at ECSF and DCSP. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. When five (5) wild populations are under protection and management (USFWS, 1994).

Recovery Priority Number: 8C

**Delisting Criteria:**
1. In addition to the five (5) populations identified in the downlisting criteria, at least five (5) additional populations are established or discovered that exhibit stable or increasing trends as evidenced by natural recruitment, and multiple age classes. (USFWS, 2019)

2. All ten (10) populations are located on lands protected via a conservation mechanism. (addresses Factors A and D). (USFWS, 2019)

3. Threats (e.g. inadequate management, invasive species) have been reduced and/or managed to a degree that Etonia rosemary will remain viable for the foreseeable future (addresses Factors A and D) (USFWS, 2019)

**Recovery Actions:**
- Protect and monitor natural populations (USFWS, 1994).
- Survey for additional populations along Etonia Creek, in Putnam County, and potential areas of scrub habitat (USFWS, 1994).
- Continue propagation at several locations to prevent extinction of the species due to disease or other disaster at any one propagation site (USFWS, 1994).

- Determine habitat requirements, life history characteristics, and requirements for reproduction (USFWS, 1994).
- Locate potential (re)introduction sites on protected lands, including public land, highway rights-of-way, and conservation easements on private land (USFWS, 1994).
- (Re)introduce plants to protected sites using plants under cultivation and/or plants from natural sites (USFWS, 1994).
- Revise the current recovery plan to include updated objective and measurable recovery criteria, as well as updated information on the species distribution and biology. (USFWS, 2019)
- Provide funding and technical support for further research on: (a) The effects of prescribed burning and other management tools (e.g., thinning sand pines or mechanical clearing to reduce the understory) on C. etonia. Continue working with public land managers to increase the management on their sites. (b) The role pollinators play in the life history of C. etonia. Additional life history information may also be needed. (c) The genetics of the different populations to determine how different they are based on geographic distribution. Genetics could also tell us if inbreeding depression is occurring in some of the smaller populations. This information will help us determine what constitutes a stable population. (USFWS, 2019)
- Acquire additional private lands within ECSF that currently contain C. etonia (USFWS, 2019).
- Work with the Service's partners for Fish and Wildlife program staff to encourage private landowners to protect this species on their lands (USFWS, 2019).
- Conduct additional surveys on public lands adjacent to ECSF and DCSP (such as along the Crescent City Ridge) to look for suitable habitat and new populations of C. etonia. Continue annual surveys of populations at ECSF and DCSP (USFWS, 2019).
- Consider reintroduction and monitoring on adjacent publicly owned lands with suitable habitat. Conduct research into whether C. etonia will hybridize with other more common Conradina species, which could equate to loss of genetic variability of C. etonia. Reintroduction of C. etonia could help to increase the number of geographically distinct, self-sustaining populations on protected sites and augment populations where needed (USFWS, 2019).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1994). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities - Manage habitat with mowing, chopping, or burning as necessary to create the open habitats that are needed for this species to thrive. - Plant the species on managed conservation lands with adequate habitat to create new populations and meet downlisting and delisting population targets. - Conserve lands with suitable habitat adjacent to the Etoniah Creek State Forest. Monitoring and Research Activities - Annually monitor current populations. - Develop methods for propagation and outplanting to increase success. - Germination trials to determine what factors promote germination and how seeds can be successfully stored (USFWS, 2024).

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# SPECIES ACCOUNT: *Conradina glabra* (Apalachicola rosemary)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/11/1993; Southeast Region (R4)

**Physical Description**

Conradina glabra is a much-branched shrub up to 2 meters tall. The branches of C. glabra are spreading or upright. The leaves are evergreen, opposite, with additional leaves in short shoots in the axils giving the appearance of fascicles. The leaves are needle-like, "very similar to the needles of fir" (Kral 1983, p. 949). The leaves are hairless on the upper surface—the only species of Conradina for which this is the case. Conradina glabra flowers from March to June and then intermittently until frost (Kral 1983). The flowers are usually in groups of two or three. The calyx and corolla are two-lipped. The corolla is 1.5 to 2.0 centimeters (0.5 to 0.75 inches) long from its base to the tip of its longest lobe, with a slender corolla tube that is straight for about 5 millimeters (mm) long, then bends sharply downward to form a funnel-shaped throat 5 mm long, then widens out into upper and lower lips. The outside of the tube and throat are white, with the lobes and lips lavender blue at the tips. The lower lip of the corolla is three-lobed, with a band of purple dots extending along its inner side. The four stamens are paired. Many flowers are male sterile. (USFWS, 1994)

**Taxonomy**

Conradina glabra was named as a distinct species by Shinners (1962), a treatment that was upheld by Gray (1965) and Kral and McCartney (1991). The plant had first been collected in 1931, and Small (1933, p. 1167) mentioned the specimen without assigning a name. (USFWS, 1994)

**Historical Range**

Historical extent and abundance of this species is unknown because the silviculture industry destroyed large areas of this species' sandhill habitat during the 1950's, and the species was not described until 1962. We can assume that the species was once more widespread within the sandhill habitat in Liberty County, Florida. (USFWS, 2017)

**Current Range**

Conradina glabra is restricted to approximately 1000 to 1470 ha in northern Liberty County, Florida, west of Tallahassee near the Apalachicola River. (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Sexual, asexual (NatureServe, 2015)

**Breeding Season**

Adult: March - first frost (NatureServe, 2015)

**Reproduction Narrative**

Adult: Reproduction for C. glabra occurs both rhizomatously/clonally and sexually via seed set, but in-situ attempts at seed germination have failed; seed viability is low. Currently, we cannot distinguish whether or not nearby stems are from the same genetic individual, so it is difficult to determine what constitutes a “plant.” For now, we will use ‘clumps’, which was also used by Pruner and Schmidt (2017) for C. glabra (USFWS, 2019).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Longleaf pine forest, field, steephead (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: 15 - 40 year fire intervals (USFWS, 2009)

**Geographic or Habitat Restraints or Barriers**

Adult: Heavy shade (USFWS, 1994))

**Environmental Specificity**

Adult: Very narrow to narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Florida rosemary (Ceratiola ericoides) requires longer fire cycles (15–40 year intervals) to maximize soil seed bank (Quintana-Ascencio et al. 2003) (USFWS, 2009). Conradina glabra occurs in an area of several square miles northeast of Bristol, Liberty County (Figure 2). The area is a gently undulating upland, originally with longleaf pinewiregrass vegetation, dissected by ravines of the Sweetwater Creek system, which drain westward to the Apalachicola River. Parts of the Apalachicola ravines are incorporated in public and private nature preserves that protect rich hardwood forests with the narrowly endemic Florida torreya (Torreya taxifolia, also federally listed as endangered) and Florida yew (Taxus floridana). Heads of ravines, called steepheads, have slopes that are undermined by groundwater seeping into the ravine bottom, causing the slopes to gradually slump, carrying the vegetation with it. At least one steephead shrub, Florida yew, appears to be adapted to slowly moving down the slopes (Redmond 1984, cited in Platt and Schwarz 1990), and C. glabra may sometimes be carried into ravines. “Many older Conradina shrubs occur at the edge of the ravine and even extend a short distance down into open areas of the ravine; younger Conradina plants have become established in the barren, exposed soil adjacent to the pines and often extend into the pine stand. This suggests that C. glabra is able to compete effectively in open, newly exposed areas but is unable to compete in closed stands of mixed hardwoods or pines. This species probably features significantly in secondary plant succession in the area, much of which is frequently subjected to burning” (Gray 1965). Wilson Baker (pers. comm. cited in Schultz 1987) suggested that Conradina spread from the ravine edges into newly planted pine plantations on the uplands during the 1950’s. Kral (1983) considered C. glabra to have inhabited the grassy understory of the upland longleaf pine-wiregrass vegetation before pine plantations were developed, as well as steephead edges. Kral thought that C. glabra was increasing in slash pine plantations, along with another woody mint, Calamintha dentata. However, Kral thought it “premature to state that this will be a stable system” because the planted slash pine had not thrived, the plantations were probably more open than had been intended, and that if the slash pines matured, they might provide “more shade and more competition than is good for the Conradina”. Most of the slash pine was cut in 1987 and replanted to sand pine (S. Gatewood, TNC, in litt., 1987). Conradina glabra currently “is found on road edges, in planted pine plantations and along their cleared edges, and along the edges of the ravines” (Baker, pers. comm., in Schultz 1987). A recent (1993) survey along the Florida Gas Transmission pipeline found an estimated 10,000 plants, artificially divided into six populations. The plants appeared to be thriving in the exposed soil along the pipeline (Biological Assessments, Florida Gas Transmission Company, Phase III Natural Gas Pipeline Expansion Project, 1993). Additionally, a new population was discovered east of State Highway 12 (R. Hilsenbeck, pers. comm.) (USFWS, 1994).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

30 - 50% decline (NatureServe, 2015)

**Species Trends:**

Stable (USFWS, 2017)

**Number of Populations:**

1 (USFWS, 2022)

**Population Size:**

>100,000 (USFWS, 2022)

**Additional Population-level Information:**

The only population on public land is found at the SCT, Torreya State Park. This area was prepared by a bulldozer scraping topsoil and remaining vegetation into linear berms called windrows, planted in slash pine (with 500-700 stems per acre of sand pine), and then logged in the late 1980s (Spector and Bente 2009). Despite this severe alteration of habitat, SCT contains the majority of C. glabra. The estimated number of plants (or ramets, see recovery action 2.1) in 2009 for 102 ha was about 89,815 (Spector 2009); current and projected counts are underway (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). At present, about 15-20% of the core known habitat within the park remains to be surveyed (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). Data are collected on an ongoing basis, allowing for trend analysis as well as assessing the effects of restoration, particularly the effects of aggressive fire. (USFWS, 2017)

**Population Narrative:**

The species is currently known from only one natural population on public land, from three introduced sites in 1991, rights-of-way, and private silvicultural lands. The population on public land, which contains most of the plants, is found at the SCT, Torreya State Park (TSP; Fig. 1). At SCT, C. glabra covers an area between 1,000 ha (2,471 acres, Spector and Bente 2014; Fig. 1) to 1,470 ha (3,632 acres, Pruner and Schmidt 2017). This area was prepared by a bulldozer scraping topsoil and remaining vegetation into linear berms called windrows, planted in slash pine (Pinus elliottii), with 500-700 stems per acre of sand pine (Pinus clausa), and then logged in the late 1980s (Spector and Bente 2009). Despite this severe alteration of habitat, SCT contains the majority of C. glabra. The estimated number of plants (or ramets) in 2009 for 102 ha was about 89,815 (Spector 2009); whereas the estimated number of plant clumps in 2017 was > 100,000. According to Pruner and Schmidt (2017), about 15-20% of the core known habitat within the park remains to be surveyed. They also provided preliminary trend analysis as well as some assessment of the effects of restoration, particularly the effects of aggressive fire (Appendix A). But current estimated counts are presently unknown due to the impact of Hurricane Michael on SCT habitat and C. glabra plants and subsequent site prepped (A. Schmidt, Wildland Resources LLC, pers. comm., 2021). (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat modification remains the main threat to date for this species as a result of silviculture practices. The entire range was altered by site preparation (e.g. bulldozing of topsoil into linear berms called windrows, and possible herbicide application) and conversion to pine plantations in the 1950s (Spector and Bente 2009). A large extent of Liberty County was logged mainly for longleaf pine, and many acres were converted to slash pine. The uplands on the SCT were managed for timber for several decades. The St. Joe Timberland Company harvested planted slash pine in1987, followed by sand pine plantation. Although C. glabra has been seen growing at the edges and sporadically within pine plantation, plant density is low compared to more open areas. Therefore, shading, due to increases in canopy cover from natural longleaf pine forests to managed pine plantations, is a threat to this species and should be evaluated. (USFWS, 2017)

**Stressor:** Inappropriate fire management (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Longleaf pine has not been introduced to the ongoing Florida Park Service forest management restoration treatments (restoration zone 2), at SCT. Introduction of longleaf pine may result in hotter fires due to needle accumulation. Also, ongoing conversations are considering a planting density of 400+ longleaf pine trees per acre to control woody species such as oak, potentially allowing for hotter fires (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). This should be closely monitored because C. glabra is also a woody species. Therefore, the use of a too frequent fire return interval and intensity could be a threat to the species. (USFWS, 2017)

**Stressor:** Herbicides (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Recovery Plan mentioned that the use of the herbicide (hexazinone, Velpar) is a threat when it is used in timber regeneration areas. According to M. Ludlow (Department of

Environmental Protection; 2009, pers. comm. to Negrón-Ortiz), spot application of Garlon 4 (a less toxic herbicide) is used to treat exotic shrubs or trees at TSP. In addition, there are almost no woody exotics in the area where C. glabra occurs. Therefore, herbicide use is currently considered a minor threat. (USFWS, 2017)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on nonfederal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. Conradina glabra is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (http://www.virtualherbarium.org/EPAC). Several sites containing C. glabra occur on private timberland and highway and utility right of way (ROWs). While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for non-federal landowners. Neither section of the Act provides protection for plants on non-federal lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. At present, we have not been able to comment on state park management practices, and the Service doesn’t have a legal mechanism to regulate management on state lands. The next revision of the park management plan will likely start around 2020 and finalized in 2022, and the Service should be able to attend public meetings and request a copy of the draft plan for commenting (R. Pruner, Florida State Parks, 9/25/2017, pers. comm.). Right of way maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting federally listed species on state highway ROWs, then the Service can recommend consultation to the Florida Department of Transportation (FDOT) under the Act because FDOT recently assumed NEPA authority and is considered a federal agency for consultation purposes. The FDOT routinely consults with the Service on all major road construction activities. Currently, these protections are inadequate for this plant and its habitat. (USFWS, 2017)

**Stressor:** Climate change (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** According to the Intergovernmental Panel on Climate Change Report (IPCC 2013), warming of the earth’s climate is “unequivocal,” as is evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. Scientific evidence indicates a rapid and abrupt climate change, rather than the gradual changes that were previously forecasted (IPCC Report 2007), posing a significant challenge for

fish, wildlife, and plant conservation. Highly specialized or endemic species, such as C. glabra, are likely to be most susceptible to the stresses of changing climate. Species that are already rare may become rarer. This may be even more pronounced for those species with restricted ranges, with poor dispersal ability, requiring long generation times, possessing susceptibility to extreme conditions (such as flood or drought), exhibiting extreme habitat/niche specialization, or requiring symbiotic relationships (Hawkins et al. 2008). Using the NOAA Sea Level Rise (SLR) and Coastal Flooding Impacts Viewer (https://coast.noaa.gov/slr/), the projections indicated no potential impact to C. glabra population in Liberty County by intrusion of saltwater. Heatwave intensities and drought events, however, have strengthened in parts of the United States including the southeast (Mazdiyasni and AghaKouchak 2014) and Florida (Gao et al. 2012), and are becoming more likely to overlap. Heatwaves can make xeric areas such as sandhills even drier, and if these concurrently occur with drought events, represent a growing threat to C. glabra survival. Thus, it is recommended to avoid or postpone prescribed-fire during extreme drought and heatwave conditions. (USFWS, 2017)

**Stressor:** Forestry and Development (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Most of the remaining population of C. glabra is now protected under ownership by the State of Florida and managed by the Florida Park Service. The private land east of SCT where C. glabra likely occurred has been recently cut. In addition, herbicide was applied to the entire tract, limiting the likelihood of C. glabra persistence in the treated area (M. Maples, Florida State Parks, 9/12/2017, pers. comm.). There are other properties adjacent to SCT that have not been surveyed, but likely contain this species. Given the ownership of these surrounding properties, it is probable that they will continue to be utilized as pine plantations or converted to residential and/or commercial development in the near future. Therefore, conversion to pine plantations and residential or commercial developments are threats. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
1. The Sweetwater Creek Tract population is assessed as resilient (addresses Factor A). Resilient: naturally reproducing, stable or increasing in number, and actively and appropriately managed. (USFWS, 2019)

2. Five additional populations are: 1) discovered or reintroduced within the historic range of the species, and 2) under long-term protection. These populations must be resilient (addresses Factors A and D). (USFWS, 2019)

**Delisting Criteria:**
1. Threat reduction and management activities (e.g., compatible silviculture practices, fire return interval and intensity, and restoration) have been implemented to a degree that the long-term resiliency of all six C. glabra populations and habitat is demonstrated over multiple prescribed burn cycles (addresses Factors A and D). (USFWS, 2019)

**Recovery Actions:**

- 1. Protect existing populations. Encourage conservation of existing populations on private lands. Conduct annual mapping and monitoring of all known populations of C glabra. Manage rights-of-way. Acquire habitat. (USFWS, 1994).
- 2. Conduct population biology studies. Study the effects of prescribed fire and forest management practices. Conduct life history studies. Survey for Conradina glabra outside its current range (USFWS, 1994).
- 3. Conduct genetic studies. Research is needed to determine genetic variability within reintroduced populations. This research will ensure that reintroduced populations have genetic variability similar to natural populations to withstand drought, diseases, etc. (USFWS, 1994)
- 4. Propagate Conradina glabra and reintroduce and/or augment populations within its historic range. Establishment of the artificial population on ABRP shows that C. glabra can be propagated and introduced rather easily. If necessary, additional reintroductions could take place on protected sites within the historic range of the plant. (USFWS, 1994)
- An in-depth C. glabra inventory across the species' historic sites and on new locations is conducted where appropriate habitat exists (addresses Factor A and redundancy). (USFWS, 2019)
- The effects of prescribed fire and forest management practices on long-term persistence of C. glabra (survival, growth and reproduction) in the sandhill community is assessed and a standardized monitoring technique is in place (addresses Factor D and resiliency). (USFWS, 2019)
- The contribution of sexual reproduction and clonal propagation to population maintenance is assessed via research related to (1) in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth), and (2) genetic composition and clonality (addresses Factors A, D, and E, and resiliency; it will inform representation). (USFWS, 2019)
- A living collection of viable germplasm3is maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach (addresses Factor E, and representation). (USFWS, 2019)
- 1. Conduct population surveys using a consistent, statistically valid, repeatable survey method. Once population numbers are known and an inventory has been conducted to find new populations throughout appropriate sandhill habitat, consistent surveys would allow for the analysis of long-term trends for this species. This information would help to determine when the species is stable and may be considered for reclassification. This information would also help to inform conservation managers of appropriate management techniques, and whether restoration of the pine plantation back to sandhill is assisting in the recovery of the species. - Continue and complete ongoing surveys throughout the present distribution. - Continue regular monitoring of marked individuals (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring). (USFWS, 2017)
- 2. Conduct an inventory of sites where appropriate habitat exists. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. (USFWS, 2017)
- 3. Identify appropriate soil types and other environmental conditions within the C. glabra range and adjacent areas as well as other sandhill areas within the Florida panhandle. This

action can include the use of aerials and species distribution modeling methods to initially determine potential habitat associations. (USFWS, 2017)

- 4. An ex-situ plant collection should be actively pursued and implemented. Studies on the viability of seeds, germination, and seedling establishment, in addition to whether the C. glabra spread by rhizomes and a persistent seed bank is present should be addressed. (USFWS, 2017)
- 5. Continue the restoration of and subsequent management of C. glabra's habitat. This is crucial for the long-term population stability (Park Service staff, 2017, pers. comm.) given that the global population of C. glabra is only found at the TSP. - Determine the fire regime (intensity) and monitor the effect of this event on C. glabra density, fecundity, and size structure. (USFWS, 2017)
- 6. Avoid or postpone prescribed-fire during extreme drought and heatwave conditions. (USFWS, 2017)
- 7. Evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change. (USFWS, 2017)
- 8. Assess the occurrence of vegetative reproduction (i.e., clonality) using genetic markers and determine the conservation implications. (USFWS, 2017)
- 9. Develop a stand-alone plan for managing listed plants at the TSP and integrate it to the restoration protocol and the Torreya State Park Unit Management Plan. - Evaluate the reference (remnant) site and determine the relevance and utility in informing restoration. (USFWS, 2017)
- 10. Seek partnership with private landowners to help better understand the present distribution of C. glabra. (USFWS, 2017)
- 11. Acquire the following properties adjacent to SCT: Candence Bank (3 parcels), Holland Ware, and R Dell Phillips. (USFWS, 2017)
- 12. The recovery plan should be updated to define objective measurable recovery criteria. A few key points to consider when addressing this action are: current population resiliency, effects of management and restoration efforts (particularly the effects of aggressive fire), and seedling recruitment. (USFWS, 2017)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Continue and complete ongoing surveys throughout the present distribution. This will assess the effect of 2018 Hurricane Michael (HM) and subsequent site prepped post HM on C. glabra at SCT. Conduct population surveys using a consistent, statistically valid, repeatable survey method (Service 2013). Once population numbers are known and an inventory has been conducted to find new populations throughout appropriate sandhill habitat, consistent surveys would allow for the analysis of long-term trends for this species. This information would help to determine when the species is stable and may be considered for reclassification. This information would also help to inform conservation managers of appropriate management techniques, and whether restoration of the pine plantation back to sandhill is assisting in the recovery of the species 2. Continue regular monitoring of marked individuals (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring). 3. In-situ seed germination and seedling recruitment studies o Many plants in fire-prone environments produce seeds that need fire, directly or indirectly, to germinate. To address whether seeds of C. glabra germinate postfire, a seed burial and retrieval experiment is recommended. 4. Investigate the longevity of seeds (soil seed bank), viability, seed germination and seedling recruitment. Ongoing by the Atlanta Botanical Garden, 2019-2021: Grant No. F18AC00195: Studies to assess resiliency and status of endangered Apalachicola rosemary (Conradina glabra). ABG proposed to 1) collect seeds from wild SCT populations, 2) test for seed viability via staining and microscopy, and 3) perform seed germination trials. 5. Conduct an inventory of sites where appropriate habitat exists. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. 6. Private land conservation Seek partnership with private landowners to assess adjacent properties to SCT [e.g., Candence Bank (3 parcels), Holland Ware, and R Dell Phillips] for the presence of C. glabra. Objectives are to: • conduct surveys and document previously unknown locations. • better understand the present distribution of C. glabra. • develop conservation goals and best management practices • secure populations via land acquisition, conservation easement, or by implementing permanent conservation measures. 7. Identify appropriate soil types and other environmental conditions within the C. glabra range and adjacent areas as well as other sandhill areas within the Florida panhandle. This action can include the use of aerials and species distribution modeling methods to initially determine potential habitat associations. 8. An ex-situ plant collection should be actively pursued and implemented. This action can be guided by the genetic study currently being carried out by the ABG (2021). 9. According to A. Stiles (DRP, pers. comm., 11/09/2021), observations suggest a decrease in the abundance C. glabra in high-density sand pine plantations, supporting restoring SCT to a Sandhill natural community. Therefore, restoration of and subsequent management of C. glabra's habitat should continue. This is crucial for the long-term population stability given that the global population of C. glabra is only found at the TSP. 10. Determine the fire regime (intensity) and monitor the effect of this event on C. glabra density, fecundity, and size structure. Ongoing. 11. Avoid or postpone prescribed fire during extreme drought and heatwave conditions. 12. Assess the occurrence of vegetative reproduction (i.e., clonality) using genetic markers and determine the conservation implications. Ongoing 13. Evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change. Partially done (Bladow et al. 2017). 14. Evaluate the reference (remnant) site and determine the relevance and utility in informing restoration. Partially done. 15. Develop a stand-alone plan for managing listed plants at the TSP and integrate it to the main management plan and the restoration protocol. (USFWS, 2022)

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# SPECIES ACCOUNT: *Conradina verticillata* (Cumberland rosemary)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 12/30/1991; Southeast Region (R4)

**Physical Description**

Cumberland rosemary, an evergreen perennial shrub in the mint family, is most noted for its aromatic leaves, which smell like the culinary herb rosemary, and for its abundant pink to purple flowers. A full technical description can be found in Gray (1965), but a few characteristics from Kral (1983), Patrick and Wofford (1981), and Roulston (1994) are presented and will aid in field identification. Inflorescence: Flowers on short-stalked, linear-bracted, axillary cymes from most or all upper nodes; the cyme stalks hispidulous; the bracts covered with long-spreading gland-tipped hairs. Flowers: They are 1 to 2 centimeters (cm) long; lavender, purple, or rarely white, usually with dark spots leading down the throat; two-lipped, the upper lip with two lobes, the lower with three; floral tube strongly bent, giving the flower an s-shape in profile; borne in small clusters in the axils of the present year's leaves from early May until early June. Calyx: Bilabiate, five-toothed, persistent, 7 to 9 millimeters (mm) long, glandular-pubescent and/or sparsely puberulent to appressed pubescent. Stems: Four-sided; woody but lax, often decumbent; seldom growing more than 1 foot tall before falling over, rooting at the nodes, and putting up more stems. Leaves: Entire, needlelike, opposite with additional pairs clustered in the axils appearing whorled, somewhat fleshy, with strongly revolute margins, 1 to 3 cm long, resin dotted, aromatic. Seeds: Up to four per calyx, dry, dark brown, spherical, 1 mm in diameter; loose in calyx but usually not falling out before calyx falls off plant. No other plants are likely to be mistaken for it when it is in flower. Without flowers, however, it resembles Aster linari~folius, Hypericum densforum, and Pycnanthemum tenuforum, which also have needlelike leaves and grow in the same habitat but do not have the distinctive rosemary aroma. (USFWS, 1996)

**Taxonomy**

Conradina is a genus of six allopatric species confined to the Southeastern United States (Shiners 1962, Gray 1965, Kral and McCartney 1991) (USFWS, 1996).

**Historical Range**

This species is known from five counties in north-central Tennessee and one county in southeastern Kentucky (USFWS, 1996).

**Current Range**

Tennessee: Cumberland, Fentress, Morgan, Scott, and White Counties; Kentucky: McCreary County. These occurrence are along nine major streams of the Cumberland Plateau--Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddys Creek, Clear Creek, and Emory River. (USFWS, 2018)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**
Adult: Asexual, sexual (NatureServe, 2015)

**Dependency on Other Individuals or Species**
Adult: Bumblebees and honeybees (USFWS, 1996)

**Breeding Season**
Adult: May - June (USFWS, 1996)

**Key Resources Needed for Breeding**
Adult: Insect pollinators (USFWS, 2018)

**Reproduction Narrative**
Adult: Flowering occurs from May to June, with fruiting in mid June. Pollination is primarily by bees, especially bumblebees and honeybees, although it attracts many different types of insects (USFWS, 1996). Less than 10 percent of the seeds are fully developed and fertile. Germination takes about 2 weeks (USFWS, 1996). C. verticillata reproduces sexually and asexually. Due to low seed viability, a majority of reproduction is the result of asexual reproduction via fragmentation (NatureServe, 2015).

**Habitat Type**
Adult: Wetland (USFWS, 1996)

**Habitat Vegetation or Surface Water Classification**
Adult: Riparian, flood plain, sand bar (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**
Adult: Seasonal flooding (NatureServe, 2015); full to moderate sunlight (USFWS, 1996)

**Geographic or Habitat Restraints or Barriers**
Adult: Excessive vegetation/shading ; saturated soil (USFWS, 1996)

**Spatial Arrangements of the Population**
Adult: Clumped (USFWS, 1996); colonial (NatureServe, 2015)

**Environmental Specificity**
Adult: Very Narrow (USFWS, 2018)

**Habitat Narrative**
Adult: Cumberland rosemary is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, 8 washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (Patrick and Wofford 1981). (USFWS, 2018)

### *Dispersal/Migration*

**Dispersal/Migration Narrative**

Adult: Dispersal seems to be mainly through fragmentation during winter storms (USFWS, 1996).

### *Population Information and Trends*

**Population Trends:**

Not available

**Species Trends:**

Unknown (USFWS, 2011)

**Number of Populations:**

3 (USFWS, 2023)

**Population Size:**

Unknown (USFWS, 2018); < 4,000 (NatureServe, 2015)

**Population Narrative:**

There currently are 66 extant occurrences; though, it is likely many others also are extant but lack current observation data to verify their persistence. While most extant sites are located on conservation lands, few are actively managed to improve habitat conditions and promote population growth of Cumberland rosemary occurrences. Data are lacking from most sites for generating reliable estimates of the species abundance, either in terms of individual clumps or genetically distinct plants. However, viability ranks assigned by Kentucky and Tennessee NHPs indicate that fewer than 100 clumps are present at 90 percent of extant occurrences. Available monitoring data suggest general trends in each of the major watersheds where the species occurs, at least among monitored sites, including declines at a majority of occurrences in the Big South Fork and Caney Fork watersheds and increases or stability at a majority of sites monitored in the Obed-Emory. (USFWS, 2018). Cumberland rosemary is represented by three populations in Tennessee and Kentucky in the Big South Fork, Emory, and Caney Fork watersheds. The species is monitored at 25 sites at varying frequency by the National Park Service's Appalachian Highlands Inventory and Monitoring Network (NPS-APHIN), Tennessee Department of Environment and Conservation (TDEC), and the Office of Kentucky Nature Preserves (OKNP) (USFWS, 2023).

### *Threats and Stressors*

**Stressor:** Habitat destruction and modification (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The potential exists that small ponds and reservoirs constructed in upper reaches of watersheds have altered hydrologic and geomorphologic processes necessary to maintain suitable conditions for the species on the cobble bars where it occurs. White (pers. comm. 2010)

reported that encroachment of woody species, both native and exotic, onto cobble bar habitats led to the decline of at least three Cumberland rosemary occurrences in Kentucky, and suggested that either drought or altered hydrology could be factors contributing to these declines. Impacts associated with hiking and equestrian trails at Big Island in BSFNRRA and impacts from vehicular and camping activity at the Lilly Bridge site in ONWSR may be a threat (USFWS, 2011).

**Stressor:** Recreational activities (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recreational activities have been identified as a potential threat to Cumberland rosemary due to trampling in areas near trails used for horseback riding and hiking, camping, off-road vehicle traffic, and whitewater boating. There is no updated information on this threat, but riparian recreation on Big South Fork NRRA, Obed WSR, and Catoosa Wildlife Management Area is still popular, and trampling remains a potential threat (USFWS, 2023).

**Stressor:** small, fragmented range (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The best available information continues to indicate that the small, fragmented range that Cumberland rosemary occupies increases the species vulnerability to localized extinction due to random events, such as natural disasters and loss of genetic diversity and adaptive potential through genetic drift (Service 2018). Low seed viability and low recruitment also reduce the species' ability to recover from habitat-related threats. These factors persist, but we are not aware of any additional studies addressing them. Research into the need for and requirements of a captive propagation program would lay the groundwork for future efforts to increase numbers of individuals and boost population size at wild sites (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 8

**Delisting Criteria:**
There are 25 protected and managed colonies with 50 genetically distinct individuals per colony on the five major rivers (five colonies on each river) where it occurs (USFWS, 1996).

**Recovery Actions:**
- Protect existing colonies and habitat. Only three populations with 91 colonies are known to exist, with the majority in north-central Tennessee and a few in adjacent Kentucky. The largest colonies in each population need immediate protection. A total of76 colonies are located on land managed by the National Park Service, and 15 sites are located on privately owned land. Only five colonies are known to have more than 100 clumps of plants. Protection of five colonies in each of the five major rivers in which Cumberland rosemary occurs is considered to be essential to the recovery of the species and to prevent its

irreversible decline. (USFWS, 1996)

- Search for new populations within the known range and in other watersheds. The search for new populations is necessary within both the known range and other watersheds. This information will be useful in making management decisions and for determining the genetic variability of the species. The most intensive searches for Cumberland rosemary in Tennessee were conducted in 1979 and 1980 (Patrick and Wofford 1981, Patrick 1979, Schmalzer and DeSelm 1982). These searches were restricted to the five major rivers within the known range of the species. Only a few new colonies have been found since 1980 (see Appendix). Suitable habitat north of and between the known Kentucky population has been thoroughly searched; no new colonies were located (White 1994). Searches should be conducted in other watersheds in Tennessee's northern Cumberland Plateau. Because of the restricted riparian habitat, access by canoe is the most efficient method of surveying for new colonies. Searches in the BSFNRRA and the 16 ONWSR should continue in order to ensure that all federally owned colonies are adequately managed and protected. (USFWS, 1996)
- Conduct studies of the species' biology. Additional information on the biology of C. verticillata is important and necessary for developing and implementing management guidelines. (USFWS, 1996).
- Maintain and expand cultivated sources for the species. Vegetative material should be preserved for the purpose of establishing new populations if natural populations were to be eliminated. (USFWS, 1996).
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation o fCumberland rosemary could play an important part in encouraging conservation efforts. In order to ensure that the taking threat is not increased, information materials should not identify specific plant locations. (USFWS, 1996).
- Annually assess the success of recovery efforts for the species. The review of new information, evaluation of ongoing actions, and redirection of recovery efforts, if necessary, are essential for assuring that full recovery is achieved as quickly and efficiently as possible. (USFWS, 1996)
- Work with NPS, TDEC, and KSNPC to reconcile data concerning extant and historic locations, abundance at extant locations, and threats (USFWS, 2011).
- Continue efforts to control invasive, exotic plants at occurrences on NPS lands at BSFNRRA and expand these efforts, as needed, to ONWSR (USFWS, 2011).
- Continue long-term monitoring begun by TDEC. Expand monitoring effort to occurrences in Kentucky. Review monitoring protocols and revise, if warranted, to provide a more repeatable system for tracking changes in distribution and abundance. Incorporate threats assessment into monitoring program (USFWS, 2011).
- Use data from NPS Cobble Bar Monitoring program to track threats to Cumberland rosemary at BSFNRRA and ONWSR (USFWS, 2011).
- Continue implementation of Recovery Plan for Cumberland rosemary (USFWS, 2011).
- · Conduct a population genetics study to assess the level of genetic variation found in the species and how that variation is distributed among watersheds and sites within watersheds; assess inbreeding risk for watersheds and occurrences; and evaluate the relationship between number of clumps/plants (ramets) 30 observed at sites and the number of genetically distinct individuals (genets) they represent. This information should be used to evaluate abundance at site and watershed levels and determine whether

population augmentation should occur in some watersheds/sites to facilitate gene flow and increase the number of compatible mates. (USFWS, 2018)

- · Coordinate monitoring efforts between KSNPC, TDEC, and NPS-APHN to avoid duplication and ensure monitoring is conducted at standardized times of year, using consistent methodology. Monitoring programs should also be designed to document threats observed at Cumberland rosemary sites, including assessing impacts of recreational activities in sites with known threats, and should attempt to document seedling recruitment into populations. (USFWS, 2018)
- · The Service's (2016) programmatic BO for streams crossings on trails at BISO included a nondiscretionary requirement that NPS coordinate with the Service to devise a monitoring plan for Cumberland rosemary that includes formally designated trail crossings and other significant sites where this plant occurs in proximity to trails in BISO. While NPS conducts monitoring at 18 sites in BISO and OBRI, there has been little coordination with the Service on the monitoring program. Some NPS monitoring sites for Cumberland rosemary are located along trails, but we do not currently know which sites, nor do we know if data are collected regarding evidence of impacts related to recreational use of trails or nearby areas. The NPS staff at BISO, OBRI, and APHN, should coordinate with the Service to evaluate whether the current NPS monitoring program includes a representative set of sites for assessing effects of recreational uses on and near trails and to establish routine coordination and reporting procedures. (USFWS, 2018)
- · Evaluate data and reports from the NPS-APHN (Murdock et al. 2013) long-term cobble bar monitoring program, to increase understanding of cobble bar geomorphology and dynamics in relation to vegetation structure and composition, as well as responses of Cumberland rosemary to changes in these habitats over time. We are not currently aware of any publicly available data or reports that have been produced from this monitoring program. (USFWS, 2018)
- · There is a need to reconcile NPS data on observations of Cumberland rosemary at OBRI and BISO with data in NHP databases. Nearly one-third (~30 percent) of all known EOs are considered historical, because there are no observations recorded for them in NHP databases since prior to 1998. The greatest number of these historical occurrences are located in the Big South Fork watershed, where NPS-APHN conduct cobble bar monitoring and other biological surveys and potentially have collected data on Cumberland rosemary occurrences (both previously known and not yet documented). While some data have been provided to Tennessee's NHP program, there is a need to ensure that NPS observation data for Cumberland rosemary and other listed species are routinely shared with NHP programs. (USFWS, 2018)
- · Once NPS and NHP data are reconciled, data should be reviewed and sites prioritized for surveys where recent observation data are lacking. Current data are needed to verify persistence of many EOs and to estimate abundance for evaluating the species' status with respect to recovery criteria. (USFWS, 2018)
- · Surveys for new occurrences should be conducted and negative data stored in a collective database. (USFWS, 2018)
- · Prioritize and increase efforts to control invasive species and assess whether additional management is needed on highest priority sites. Document areas where invasive species control and other habitat management occurs. (USFWS, 2018)
- · Additional seed banking and testing of seed viability are needed to provide adequate ex situ resources for conservation of the species. (USFWS, 2018)

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# SPECIES ACCOUNT: *Cordylanthus maritimus ssp. maritimus* (Salt marsh bird's-beak)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/29/1978; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

A hemiparsitic annual herb, 1-3 dm tall, with grayish-green, herbage, often tinged with purple. Specimens are branched and may be up to 16 inches (40 centimeters) tall with numerous flowers arranged on flower stalks termed spikes. The flowers of some C. maritimum taxa have showy pale pink pouches with darker purple lips on purplish-green plants. The hairiness of the foliage and stems is variable, and most plants have visible salt-encrusted glandular hairs. Chloropyron maritimum ssp. maritimum may occur as short, erect, scarcely branched plants, or as plants with a profusion of spreading or ascending branches. (USFWS, 2013; NatureServe, 2015)

**Taxonomy**

At the time Chloropyron maritimum ssp. maritimum was listed (as Cordylanthus maritimus ssp. maritimus), the genus Cordylanthus was placed in the Scrophulariaceae (figwort family). However, based on molecular systematic studies using DNA sequences of three plastid genes, Olmstead et al. (2001) transferred the hemiparasitic group Castillejiinae, including Cordylanthus, to the Orobanchaceae. Though the taxon continues to be called Cordylanthus maritimus ssp. maritimus on the Federal List of Threatened and Endangered Wildlife and Plants (List) pursuant to the Endangered Species Act (Act) (16 U.S.C. 1531 et seq.), here we use the currently accepted name, Chloropyron maritimum ssp. maritimum. The species is divided into northern and southern coastal subspecies, and an inland subspecies. Chloropyron maritimum ssp. maritimum, the southern California coastal subspecies, is distinguished from the northern ssp. palustris, mainly by geographic distribution in that it occurs from Morro Bay south through southern California. It is also distinguished by branching patterns, growth habit, narrower and more acute leaves, and variations in seed size and floral traits (Chuang and Heckard 1973, 1993). The three intergrading subspecies have distinct ecological and geographical distributions. Chloropyron maritimus ssp. canescens (hoary salt marsh bird’s-beak) is a widely distributed, but uncommon, plant of inland saline/alkaline wetlands of the Great Basin; Chloropyron maritimum ssp. maritimum (salt marsh bird’s-beak), an endangered tidal marsh plant limited to few populations in southern California and Baja California, Mexico; and Chloropyron maritimum ssp. palustre (Point Reyes bird’s-beak), a similar rare tidal marsh plant from San Francisco Bay to Oregon. (USFWS, 2013)

**Historical Range**

Historically, C. maritimum ssp. maritimum was widespread near the upper edges of coastal tidal marshes from Morro Bay in San Luis Obispo County to San Diego County and northern Baja California. (USFWS, 2013)

**Current Range**

Chloropyron maritimum subsp. maritimum is currently known to persist in seven coastal salt marshes: San Diego County at Tijuana Estuary (separated into Border Field State Park and

Tijuana Slough NWR), Naval Radar Receiving Facility (NRRF), and Sweetwater Marsh Unit of San Diego Bay NWR; Orange County at Upper Newport Bay (State) Ecological Reserve; Ventura County at Naval Base Ventura County, Point Mugu; Santa Barbara County at Carpinteria Salt Marsh; San Luis Obispo County at Morro Bay. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

**Dependency on Other Individuals or Species**

Adult: Bees are thought to be the principal pollinators of ssp. maritimum at other locations (Parsons and Zedler 1997).

**Breeding Season**

Adult: May to October (USFWS, 2009)

**Reproduction Narrative**

Adult: Chloropyron maritimum subsp. maritimum is a taxon of annual plants in the Orobanchaceae (broom rape family). The flowering period is between May and October (Munz 1974, p. 801; Naval Base Ventura County Point Mugu 2003, p. 1). Each flower may produce 10-40 seeds with an average of 15 to 20 seeds per capsule (Chuang and Heckard 1993, p. 1029). (USFWS, 2009)

**Habitat Type**

Adult: Estuarine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Herbaceous wetland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Requires water salinities between 5 to 33 parts per thousand and less than 12 parts per thousand for germination (USFWS, 2013)

**Geographic or Habitat Restraints or Barriers**

Adult: Requires periodic tidal inundation; prefers brackish to tidal marsh with low vegetative cover (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Patchy (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: Plants have naturally patchy distributions in sites subject to only higher tidal influxes in coastal salt marshes. (USFWS, 2009). The range of salinity associated with growth of ssp. maritimum is 5 to 33 parts per thousand, but pulses of freshwater from flooding or rainfall are probably necessary for germination (Parsons and Zedler 1997). Salinity at the time of germination usually cannot exceed 12 parts per thousand (Newman 1981). Populations generally occur in areas with low salinity in the spring and low vegetative cover (Newman 1981, Dunn 1981). Cordylanthus maritimus spp. maritimus roots form haustoria to obtain water and nutrients through the roots of other host plants. Chloropyron maritimum ssp. maritimum can grow without host plants (Chuang and Heckard 1971), but hemiparasitism may permit them to flourish in the hot, dry, higher soil-salinity conditions of summer (Vanderwier and Newman 1984). (USFWS, 2013; USFWS, 2009)

***Dispersal/Migration***

**Dispersal**

Adult: High (USFWS, 2013)

**Dependency on Other Individuals or Species for Dispersal**

Adult: Animals, especially birds (USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: Physical factors such as currents, tides, wave action, and sheet erosion are among the ways seeds are moved around within and between marshes. The seeds of C. maritimum ssp. maritimum have a honeycombed surface that traps air bubbles and makes them highly buoyant. They have been shown to float for up to 50 days and floatation may be the primary local dispersal mechanism for C. maritimum ssp. maritimum (Newman 1981). Animals, especially birds, may carry the seeds on their feet, or in their fur, feathers, or digestive systems (U.S. Fish and Wildlife Service 1985a). (USFWS, 2013)

***Population Information and Trends***

**Population Trends:**

Decline of >30% (NatureServe, 2015)

**Number of Populations:**

9 (USFWS, 2020)

**Population Size:**

30,000 (highly variable) (NatureServe, 2015)

**Population Narrative:**

CHMAMA is currently extant at nine coastal marsh complexes across the species' range, including seven marsh complexes in the United States [Morro Bay, Carpinteria Salt Marsh, Ormond Beach/Mugu Lagoon, Upper Newport Bay, San Diego River Mouth, San Diego Bay (including Sweetwater Marsh) and Tijuana Estuary], and two marsh complexes in Baja California, Mexico (Estero Punta Banda, and Bahía de San Quintín). One new population has been established since the last 5-year review, at the San Diego River Mouth. Conservation efforts have occurred and are ongoing throughout the subspecies' range, including work to introduce CHMAMA at Magnolia Marsh, within the Huntington Beach Wetlands. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, Chloropyron maritimum subsp. maritimum occurred in many more salt marshes than it did at the time of listing. Many of these salt marsh areas were either filled in for development (e.g. Artesia and Long Beach in Los Angeles County) or cleared for marinas (e.g. Mesmer near Santa Monica in Los Angeles County). Diversion of fresh water from the salt marsh areas may also have led to the habitat becoming unsuitable to sustain C. maritimum subsp. maritimum populations. (USFWS, 2009)

**Stressor:** Off-highway vehicles (OHVs) (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts from off-highway vehicles have been reported for some occurrences of Chloropyron maritimum subsp. maritimum (CNDDB 2008). These occurrences are in San Diego County in an area of the Tijuana Slough NWR in the Tijuana Estuary where OHV activity is controlled by the Refuge managers; in Orange County at Upper Newport Bay where OHV activity is controlled by managers of the Upper Newport Bay State Ecological Reserve; in Ventura County at Ormond Beach where OHV activity is controlled to a degree by the Coastal Conservancy and The Nature Conservancy's Conservation Easement, and at the Ventura County Naval Base Point Mugu (CNDDB 2008). Potential impacts from OHVs are currently minimal and management measures are in place to minimize these impacts. (USFWS, 2009)

**Stressor:** Hydrological changes (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Modification for natural tidal flow in Point Mugu Lagoon in Ventura County, noted as a threat in the listing rule, was completed in about 1980. As a result, a portion of the populations at the occurrence were destroyed, but most remained. Since listing, increased tidal flow at one site in the Carpinteria Marsh in 1984 reportedly created wetter conditions (CNDDB 2008, EO 17). However, there are no subsequent reports on the precise location of the site or condition of plants in the area and occurrences in the area are presumed to be extant (CNDDB 2008). Hydrological alterations to promote populations of endangered birds (e.g., light-footed clapper rail) have taken place at historical occurrence sites of Chloropyron maritimum subsp. maritimum, though the impact on plant populations is unknown. (USFWS, 2009)

**Stressor:** Global climate change (USFWS, 2009)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** According to the Intergovernmental Panel on Climate Change (IPCC) there has been a general but measured increase in global average temperatures since the turn of the century (IPCC WG I 2007, p. 6). This translates to the fact that the average temperature of the ocean has also risen. The same is true for global average sea level (IPCC WG I 2007, p. 6). The total rise in sea level during the 20th century is estimated to be about 0.56 feet (0.17 meters). This means that the tidal flows will encroach further into all coastal marshes including those that support C. m. subsp. maritimum. The impact on distribution of associated vegetation and host plants is unknown. Although the degree of sensitivity Chloropyron maritimum subsp. maritimum to incremental changes in sea level is unknown, ultimately, it is likely that the full extent and distribution of populations will be affected and likely move inland or up the elevational gradient. The populations could potentially migrate inland in step with changes in the estuarine hydrology as long as the physiography of the site allowed. The physiography of each occurrence differs, which in turn dictates whether or not C. maritimum subsp. maritimum can naturally migrate to other suitable sites. The potential for adjacent habitats to become suitable for C. maritimum subsp. maritimum as the inundation regime changes also likely varies from occurrence to occurrence. Habitat for C. maritimum subsp. maritimum at generally broad open estuaries such as Tijuana Estuary in San Diego County and Point Mugu in Ventura County would persist more readily than that at Newport Bay in Orange County where the adjacent bluffs could preclude inland migration of the habitat. Sea level rise poses a significant rangewide threat to all extant occurrences of C. maritimum subsp. maritimum and coastal marsh areas under consideration for restoration and/or enhancement. (USFWS, 2009)

**Stressor:** Storm drain runoff (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, erosion from storm drain runoff is listed as a threat to occurrences in Upper Newport Bay in Orange County (CNBBB 2008). This runoff is generated by neighborhoods on the bluffs above the bay. Projections of precipitation as less snow and more rain (CEC 2006, p. 31) mean that there would likely be more runoff than is currently experienced. The amount and timing of runoff impacts coastal salt marsh habitat and any changes due to climate change likely result in changes to the condition and distribution of suitable habitat for Chloropyron maritimum subsp. maritimum. (USFWS, 2009)

**Stressor:** Herbivory (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, herbivory by the microlepidopteran, salt marsh snout moth (Lipographis fenestrella) has been documented (Parsons and Zedler 1997, p. 259). This is listed in CNDDB as insect damage for a few of the occurrences (Appendix 1). The larvae of the moth consume capsules and even unfertilized ovaries, however, a large number of capsules escape attack (Parsons and Zedler 1997, p. 259). These authors report that although there was more damage between mid-May and mid-June there was no correlation with environmental variables. The extent and impact of herbivory to populations of Chloropyron maritimum subsp. maritimum is unknown. (USFWS, 2009)

**Stressor:** Trampling (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, new threats from trampling have been reported for occurrences at the Naval Radar Receiving Station (NRRF), San Diego County, Upper Newport Bay Ecological Reserve, Orange County, and at the south end of Morro Bay, San Luis Obispo County (Appendix 1). The extent and persistence of the threats from trampling is unknown. (USFWS, 2009)

**Stressor:** Nonnative plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing nonnative plants (e.g. Limonium spp. (sea-lavender) and Carpobrotus spp. (sea-fig)) have been noted as a new threat to Chloropyron maritimum subsp. maritimum at occurrences in Santa Barbara County (e.g., Carpinteria ) (CNDDB 2008) and San Luis Obispo County (e.g., Morro Bay) (CNDDB 2008). No specific impacts were provided, thus the nature and magnitude of this threat cannot be assessed at this time. These invasive plants may alter movement and availability of fresh water or otherwise preclude germination and growth of the Chloropyron maritimum subsp. maritimum and/or its hosts. (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. Fifteen acres [6 hectares] of secured and protected high marsh habitat at appropriate elevations is required at a minimum of eight marshes for a period of at least five consecutive years. (USFWS, 2009)

**Delisting Criteria:**
1. Twenty acres [8 hectares] of secured, protected, and managed high marsh habitat at appropriate elevations is required at each of the 12 major marshes within the historical range of the plant for a period of ten consecutive years. (USFWS, 2009)

**Recovery Actions:**
- Conservation easements or fee-title purchase from willing sellers should be sought to place remaining undeveloped shoreline under protective ownership. (USFWS, 2013)
- Many of the threats facing the subspecies are aggravated by its small population size and limited range-wide distribution; therefore, population augmentation and initiation of new subpopulations in suitable unoccupied habitat at Morro Bay should be planned and implemented to reduce the risk of regional extinction. (USFWS, 2013)
- Morro Bay populations of Chloropyron maritimum ssp. maritimum are sensitive to trampling and disturbance and should be protected, by use of fencing, against recreational pressures from nearby residential areas and from park visitors. Access and trails should be routed away from sensitive habitat. Boat haulouts near populations of C. maritimum ssp. maritimum must be curtailed. Dredge disposal should be managed to minimize the risk of sand movement burying subpopulations of the species. (USFWS, 2013)
- Shoreline stands of Carpobrotus edulis (iceplant) should be eradicated and replaced with native marsh-upland ecotone vegetation. Other non-native plants should be controlled to

prevent crowding, shading, or other impacts to the salt marsh bird's-beak and its habitat. (USFWS, 2013)

- Populations of Chloropyron maritimum ssp. maritimum should be monitored annually for distribution, abundance, and reproductive output. (USFWS, 2013)
- Continuing and new threats should be identified and reported. Disturbances and sand dune movement should be monitored, and measures to address impacts—as well as to evaluate the success of these measures—should be developed. (USFWS, 2013)
- Management plans that address protective and population augmentation actions for Chloropyron maritimum ssp. maritimum should be developed and implemented for lands in public or conservation ownership. (USFWS, 2013)
- Resurvey historical and extant occurrences, especially inland salt marsh habitats, to detect presence and local distribution of plants. There is some potential for the inland occurrences to have persisted. (USFWS, 2009)
- Develop a threats-based recovery plan to guide conservation actions for the species. Incorporate SLAMM assessments of sea level change. (USFWS, 2009)
- Determine the distribution of genetic diversity at extant occurrences. This will assist us in identifying pollinators and pollen sources should pollen transfer among occurrences prove necessary. As part of this effort, verify the subspecific relationships of the occurrences in Morro Bay. (USFWS, 2009)
- Prepare site specific monitoring protocols to determine, if possible, fine-scale habitat requirements and species fidelity to those habitat requirements. This will allow us to discriminate between lack of seed dispersal and unsuitable habitat as explanations for discontinuities in plant distributions. (USFWS, 2009)
- Establish site and species monitoring protocols, based on those developed by VFWO at Point Mugu, to identify potential impacts of sea level changes associated with climate change. This will help detection of species responses to long term changes in sea level and associated vegetation. (USFWS, 2009)
- Work with partners to help conserve Chloropyron maritimum subsp. maritimum. Identify opportunities through the Service's Partners for Fish and Wildlife and Coastal Programs to seek habitat restoration and enhancement opportunities. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Continue to work with partners to expand the current distribution of CHMAMA, including planning, site selection, and augmentation and reintroduction efforts. 2. Collect voucher specimens and conduct genetic work to resolve taxonomic questions about the distribution of the listed entity, especially at Morro Bay. 3. Continue to support partners in removing nonnative Limonium from occupied marshes. Conduct additional research into CHMAMA seed tolerance to solarization when treating Limonium. 4. Engage stakeholders and species experts in CHMAMA sea-level rise planning. 5. Conduct additional research into environmental covariates important for CHMAMA abundance at marshes, using existing monitoring data where available. (USFWS, 2020)

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# SPECIES ACCOUNT: *Cordylanthus mollis ssp. mollis* (Soft bird's-beak)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/20/1997; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

Chloropyron molle ssp. molle is an erect annual herb in the Orobanchaceae (broomrape) family. Mature plants range from approximately 10 to 40 cm (4 to 16 in) tall. Stems and leaves are gray-green, often purple-tinged, and covered with very fine hairs bearing glands as well as longer soft non-glandular hairs. Leaves and stems are sparsely to heavily covered with crystals of salt exuded from leaf glands. Leaves are typically 1.0 to 2.5 cm (less than 0.5 to 1.5 in long, oblong, and may be entire or pinnately lobed 3 to 7 lobes). The tubular flowers are pale cream to yellowish at the tip, and crowded together in spikes 5.0 to 15.0 cm (2 to 6 in long). The fruit is a capsule, approximately 8 mm (0.3 inch) long (Ruygt 1994). (USFWS, 2013)

**Taxonomy**

At the time Chloropyron molle ssp. molle was listed (as Cordylanthus mollis ssp. mollis), the genus Cordylanthus was placed in the Scrophulariaceae (figwort family). However, based on molecular systematic studies using DNA sequences of three plastid genes, Olmstead et al. (2001) transferred the hemiparasitic group Castillejiinae, including Cordylanthus, to the Orobanchaceae, thereby placing it in the genus Chloropyron. The species Cordylanthus mollis was split into two subspecies by Chuang and Heckard (1973), based on geographic variation in spike length, branching pattern, corolla hair density, seed size, and hair stiffness. Chloropyron mollis ssp. hispidus is distinguished from ssp. molle by its pronounced bristly stem and leaf hairs, and its growth habit of branching strongly from the base of the plant. The flowers of ssp. hispidus are sparsely hairy, not densely tomentose (woolly) as in ssp. mollis. Within its range, Chloropyron molle ssp. molle can be distinguished from two other taxa in the Scrophulariaceae that occur in brackish tidal marshes: Chloropyron maritimum ssp. palustre and Castilleja ambigua. When in flower, C. maritimum ssp. palustre is readily distinguished from C. molle by its rose-purple and pinkish-white flowers, and the presence of four fully developed stamens (not two plus two vestigial stamens, as in C. molle). The inner bracts of C. maritimum ssp. palustre are notched, not lobed, while the bracts of C. mollis are pinnately lobed. C. ambigua flowers in spring (variably late March to May) before C. molle. The bracts and leaves of C. ambigua are palmately cleft, not pinnately lobed as in C. molle. Although, typical C. ambigua ssp. ambigua has white and yellow flowers like C. molle, the Point Pinole population of ssp. ambigua and other historical San Francisco Bay populations have flowers that mature and senesce with a purplish tinge (P. Baye unpubl. data 1997-2000), as do the white-tipped bracts (Chuang and Heckard 1993). In contrast, the bracts of C. molle are gray-green or a blend of gray-green and dull dark purplish highlights, and its flowers are creamy yellow or yellowish-green and lack an open beak tip that allows the stigma to protrude (Chuang and Heckard 1993). (USFWS, 2013)

**Historical Range**

Endemic to California, reported from Contra Costa, Marin, Napa, Solano, Sonoma, Sacramento, and Del Norte counties. (NatureServe, 2015)

**Current Range**

The species is currently restricted to widely scattered populations in Napa, Solano, and Contra Costa Counties, from Point Pinole and Fagan Slough marsh through the Carquinez Strait to Suisun Bay. (USFWS, 2009)

**Critical Habitat Designated**

Yes; 4/12/2007.

**Legal Description**

On April 12, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cordylanthus mollis ssp. mollis (Soft bird's-beak) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (72 FR 18518-18553).

**Critical Habitat Designation**

The critical habitat designation for Cordylanthus mollis ssp. mollis includes five CHUs in Contra Costa, Napa, and Solano Counties, California. This species critical habitat encompasses approximately 2,276 acres (ac) (921 hectares (ha)) (72 FR 18518-18553).

Unit 1: Fagan Slough Marsh (Napa County): Unit 1 consists of approximately 384 ac (156 ha) located adjacent to the Napa River to the west, Napa County Airport to the east, Fagan Slough to the south, and Steamboat Slough to the north. This unit consists of 297 ac (120 ha) of Stateowned land (Fagan Slough Ecological Reserve), which is managed by the CDFG, 6 ac (2 ha) of county-owned land, 9 ac (4 ha) of land owned by the City of Napa, and 72 ac (29 ha) of privately owned land. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations regularly (NWI 2005) from the abovementioned tidal sloughs and the Napa River.

Unit 2: Hill Slough Marsh (Solano County): Unit 2 for Cordylanthus mollis ssp. mollis consists of approximately 525 ac (213 ha) located north of Potrero Hills between Grizzly Island Road and Highway 12. The unit consists of approximately 440 ac (178 ha) of Stateowned land (Hill Slough Wildlife Area), which is managed by the CDFG, and 85 ac (35 ha) of privately owned land. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations irregularly (not daily) (NWI 2005) from Hill Slough and a flood control channel along the western unit boundary.

Unit 3: Point Pinole Shoreline (Contra Costa County): Unit 3 consists of approximately 22 ac (9 ha) located along the Contra Costa shoreline in San Pablo Bay just east of Point Pinole. This unit consists of 13 ac (5 ha) of County-owned land (Point Pinole Regional Shoreline Park), which is managed by the East Bay Regional Park District, and 9 ac (4 ha) of Stateowned land. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations on a regular basis (NWI 2005) from natural and artificial (dredged) tidal channels within the unit. Additional special management considerations or protections beyond those discussed above may be required to minimize the impact of industrial or commercial encroachment from the south that could increase stormwater and wastewater runoff into the unit.

Unit 4: Rush Ranch/Grizzly Island Wildlife Area (Solano County): Unit 4 for Cordylanthus mollis ssp. mollis consists of approximately 1,181 ac (477 ha) located adjacent to Suisun Slough to the west, Cutoff and Montezuma Sloughs to the south, and Potrero Hills to the North. This unit consists of 231 ac (93 ha) of State-owned land (Joice Island portion of the Grizzly Island Wildlife Area), which is managed by the CDFG, and 950 ac (384 ha) of land owned and managed by the Solano Land Trust (local non-profit public land trust). Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations regularly (at least once daily) (NWI 2005) from the above-mentioned tidal sloughs).

Unit 5: Southampton Marsh (Solano County): Unit 5 consists of approximately 164 ac (66 ha) of State-owned land managed by the California Department of Parks and Recreation (CDPR) as a wetland natural preserve (CDPR 1991, p. 44). The unit is located in the Benicia State Recreational Area along Interstate Highway 780 and just northwest of the City of Benicia. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations on a regular-to-irregular basis (NWI 2005) from natural and artificial (dredged) tidal channels within the unit. Additional special management considerations or protection of the PCEs beyond those discussed above may be required to minimize the impact of residential encroachment from the north that could increase stormwater and wastewater runoff into the unit.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cordylanthus mollis ssp. mollis critical habitat consists of three components (72 FR 18518-18553):

(i) Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);

(ii) Open channels that periodically contain moving water with oceanderived salts in excess of 0.5 percent; and

(iii) Gaps in surrounding vegetation to allow for seed germination and growth.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing and that contain the PCEs may require special management considerations or protection. Most of the PCEs and the known occurrences of Cirsium hydrophilum var. hydrophilum and Cordylanthus mollis ssp. mollis are threatened by: (1) tidal wetland conversions to diked, managed, or muted tidal marshes; (2) changes to channel water salinity and tidal regimes; (3) mosquito abatement activities; (4) marsh invasions by nonnative plants; (5) plant-eating insects; (6) urban, industrial, and agricultural encroachment; (7) impacts from livestock overgrazing; (8) feral pigs (Sus scrofa); and (9) impacts from unauthorized foot and off-road vehicle traffic. These combined threats result in the loss and fragmentation of suitable habitat for C. hydrophilum var. hydrophilum and C. mollis ssp. mollis, which could significantly affect their long-term survival. Individually, these threats may require special management considerations or protection as addressed under the critical habitat unit descriptions below.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

**Lifespan**

Adult: 1 year (USFWS, 2009)

**Breeding Season**

Adult: July to September (NatureServe, 2015)

**Reproduction Narrative**

Adult: Cordylanthus mollis ssp. mollis is a hemiparasitic annual herb in the Orobanchaceae (broomrape) family with flowers that bloom from July to September. The number of seeds produced per plant ranged from 91 to 790, depending on year and microhabitat (Futrell in litt. 2013). C. mollis ssp. mollis can hybridize with C. mollis ssp. hispidus indicating sexual reproduction (USFWS, 2009; USFWS, 2013)

**Habitat Type**

Adult: Estuarine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Tidal flat/shore (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Prefers higher soil salinity and hydroperiods (USFWS, 2013)

**Geographic or Habitat Restraints or Barriers**

Adult: Found in high marsh near limits of tidal action (USFWS, 2009)

**Spatial Arrangements of the Population**

Adult: Colonies (USFWS, 2013)

**Environmental Specificity**

Adult: Very Narrow (inferred from USFWS, 2009)

**Dependency on Other Individuals or Species for Habitat**

Adult: As a hemiparasitic plant, seedling survival in Cordylanthus mollis ssp. mollis is critically dependent on establishing an early connection with a suitable host plant. (USFWS, 2009)

**Habitat Narrative**

Adult: Cordylanthus mollis ssp. mollis is found predominantly in the high marsh (upper reaches) of salt grass-pickleweed marshes at or near the limits of tidal action (Stromberg and Villasenor

1986) and is associated with Salicornia virginica (pickleweed), Distichlis spicata (salt grass), Jaumea carnosa (fleshy jaumea), Frankenia salina (alkali heath), and Troglochin maritima (arrow-grass) (Stromberg and Villasenor 1986). Seedling survival in Cordylanthus mollis ssp. mollis is critically dependent on establishing a connection with a suitable host plant. Typical host plants include Distichlis spicata (salt grass) and Salicornia virginica (pickleweed) (Grewell et. al. 2003, Grewell 2004). Most known Cordylanthus mollis ssp. mollis occurrences are found in regularly flooded and permanently saturated habitats within mixed halophytic plant communities, that is, communities where plants are adapted to live and reproduce in salt or brackish water (NWI 2005) with extended tidal hydroperiods and somewhat higher soil salinity (Grewell 2004). (USFWS, 2009; USFWS, 2013)

***Dispersal/Migration***

**Dispersal**

Adult: Moderate (USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: Seeds may disperse short distances from parent plants by tidal inundations or animals (Grewell et al. 2003), but successful long-distance dispersal by these or other means has not been documented. Repeated surveys indicate that most dispersal occurs over short distances (Ruygt 1994) on the order of 10 meters [11 yds] or less (Grewell et al. 2003). (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

11 (USFWS, 2009)

**Population Narrative:**

Although no recent comprehensive status surveys have been conducted, the latest information indicates that 11 extant populations of Cordylanthus mollis ssp. mollis are currently distributed within 50 percent of the historical range and that a large percentage of the remaining plants are in Solano County (Grewell et. al. 2003). In the final listing rule, it was reported that the number of individuals within the populations varied from 1 to 150,000 plants and that most sites varied between 1,000 and 6,000 plants (CNDDB 1996). (USFWS, 2009)

***Threats and Stressors***

**Stressor:** Altered tidal regimes (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, continuation of altered tidal regimes still occurs in much of the potential habitat and represents both the most significant historical and current threat to Cordylanthus mollis ssp. mollis and its habitat. With respect to effects to C. mollis ssp. mollis, alteration of tidal regime includes muting of tidal flows, increases in freshwater runoff, or decreases in freshwater

inflows such as diversion of freshwater for agricultural and municipal uses, that increase salinity. (USFWS, 2009)

**Stressor:** Habitat loss (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cordylanthus mollis ssp. mollis habitat in the San Francisco estuary has dwindled over the last 200 years, San Pablo Bay and Suisun Bay having experienced 70 and 79 percent reductions in tidal marsh, respectively (Goals Project 1999). Historically, a large portion of tidal marshes in San Pablo Bay were diked and managed for agricultural production and livestock grazing (discussed further under Factor E), whereas, in Suisun Bay, most historical tidal marshes were diked and managed for waterfowl, though cattle grazing also occurred. These historical reductions of habitat have affected the extent and composition of tidal marsh communities. As a result, many native halophytic (salt-tolerant) plants are exceedingly rare in tidal marshes within the estuary (Goals Project 1999). (USFWS, 2009)

**Stressor:** Muting tidal flows (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some Cordylanthus mollis ssp. mollis occurrences exist in muted tidal marshes around the perimeter of high tidal areas near Hill Slough and Fagan Slough marshes, where they were once completely diked and managed. The occurrences of C. mollis ssp. mollis populations in muted marshes, though, may likely be a result of dormant seed banks and associated marsh conditions that still promote their establishment. These populations face the risk of extirpation if the levee fails or is unmaintained in the future. Also, future land use and management activities that further mute tidal flows in these marshes may rapidly alter marsh conditions to further restrict or exclude the subspecies from the local plant community (Goals Project 1999). Muting of tidal flows is known to have extirpated Cordylanthus mollis ssp. mollis in at least one instance. Mitigation for the expansion of the Potrero Hills Landfill, initiated in 2002, involved extending tidal flows into a mitigation area to support vernal pool species, thereby reducing, and in some cases eliminating, tidal flows from the Hill Slough area which supported C. mollis ssp. mollis. Continuous hydrologic recorders in place at the site since 2001 to support local restoration research documented the change in hydrology that resulted in negative impacts to C. mollis ssp. mollis. (USFWS, 2009)

**Stressor:** Freshwater inflow (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes to freshwater inflow have also modified the habitat for this species. For example, at BSRA, increased freshwater runoff from nearby urban development has replaced halophytic communities (including species such as Salicornia virginica (pickleweed) with freshwater emergent marsh communities not appropriate as host plants (Grewell, pers comm. 2007). (USFWS, 2009)

**Stressor:** Agriculture and municipal uses (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Agricultural and municipal uses have diverted much historical annual inflow of freshwater from the Suisun Marsh and Delta, creating a more saline environment. In addition, artificially variable soil salinities may threaten Cordylanthus mollis ssp. mollis by reducing the distribution and abundance of its host plants. (USFWS, 2009)

**Stressor:** Sea level rise (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of Cordylanthus mollis ssp. mollis. Conservation of high marsh zones in the face of sea level rise requires landward migration of the marsh profile on broad, sloping plains (Field et al. 1999, Baye 2006). Many alluvial terraces and valleys adjacent to the estuary are bordered by steep levees or are already converted to intensive agriculture, residential, or commercial development. In Suisun and northern San Pablo Bay, however, some undeveloped grazing land remains. Conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could cease to support C. mollis ssp. mollis habitat (Grewell 2006). Land use planning and economic pressures that favor conversion of “underdeveloped” grazing lands contribute to the loss of potential transgressive high marsh habitat for long-term viability of the species (Baye 2006). (USFWS, 2009)

**Stressor:** Mosquito abatement (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mosquito abatement activities noted in the final listing rule continue to threaten Cordylanthus mollis ssp. mollis populations, though to a lesser degree than the above threats. Specifically, ditch cleaning and dredging along first order channels for mosquito abatement purposes alter the natural hydrology of the habitat and chemical spraying of vegetation threatens the species as well. Off-road vehicle traffic associated with mosquito control (discussed under Factor A) continues to threaten Cordylanthus mollis ssp. mollis populations in most known locations (Grewell 2005; CNDDB 2006). Foot traffic in Suisun Marsh at the time of listing was believed to contribute to habitat degradation via trampling. Foot traffic remains a threat today, specifically via excessive recreational and research access (Grewell, pers. comm. 2007). (USFWS, 2009)

**Stressor:** Seed predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Intense seed predation by insects was reportedly observed at Joice Island and Hill Slough within the Suisun Marsh in Solano County (U.S. Fish and Wildlife Service 1997). Insect predation reportedly was responsible for decline in one of the largest populations of

Cordylanthus mollis ssp. mollis. Since the time of listing, much light has been shed on the specifics of C. mollis ssp. mollis seed predation which still poses a threat to populations in Suisun Marsh. Cordylanthus mollis ssp. mollis seed production can be significantly influenced by pre-dispersal seed predation from moth larvae (Saphenista spp., Tortricidae and salt marsh snout moth, Lipographis fenestrella, Pyralidae) (Ruygt 1994; Grewell et al. 2003). Areas with muted tidal regimes can support the subspecies (CDWR 1999), but increased tidal muting can constitute a threat to C. mollis ssp. mollis by increasing the prevalence of unsuitable host plants, and by changing the balance of seed production to seed predation maintained between the plant and seed-eating moths, such as various Saphenista species (Grewell 2004; Grewell 2006). The moth larvae burrow in the sediment during part of their life cycle, so reduced tidal flooding may improve their survivorship. Under full tidal regimes, the interaction between the rare Lepidopteran moth (Cordylanthus mollis specialist) and its rare plant host appears to be in balance (Grewell et al. 2003;Grewell 2004). (USFWS, 2009)

**Stressor:** Non-native plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Aside from the alteration of natural tidal cycles, the most significant threat to the species is that from invasion of non-native plants, especially winter annuals, which are inappropriate host plants. Since the time of listing, the threat posed by nonnative plant competitors and winter annuals as inappropriate host plants has become more defined. Lepidium latifoium (perennial pepperweed) and Spartina patens (salt-meadow cord grass) are two non-native species endangering native tidal marsh ecosystems in the range of Cordylanthus mollis ssp. mollis (Grewell 2005). Both plants are highly invasive, however L. latifolium is thought to be a more significant threat due to its proximity to C. mollis ssp. mollis occurrences, especially in Suisun Marsh. Lepidium latifolium is also of particular concern because it forms large monospecific patches that displace native marsh vegetation. L.C. Lee and Associates (2003) observed that one of the five most dominant associates of C. mollis ssp. mollis at Rush Ranch, based on canopy coverage in sample plots, was L. latifolium. Lepidium latifolium is a highly invasive non-native plant that forms monospecific stands that are very difficult to remove. Spartina patens also exists in the general vicinity of Cordylanthus mollis ssp. mollis habitat. It presents a more minor threat to C. mollis ssp. mollis because it is not known to exist along the high marsh edge. However, it does present a threat to the high marsh plant community in general in that the species displaces native habitat essential for a fully functioning ecosystem. (USFWS, 2009)

**Stressor:** Inappropriate hots plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** High levels of premature mortality were found to be correlated with the presence of non-native winter annual grasses in the immediate vicinity of C. mollis ssp. mollis seedlings (Grewell et al. 2003). Non-native winter annuals such as Hainardia cylindrica (bargrass) and Polypogon monspeliensis (annual rabbitsfoot grass) or native winter annuals such as Juncus bufonius (toad rush) are not suitable hosts since they typically die before C. mollis ssp. mollis can flower and produce seeds (Grewell et al. 2003, 2004). The prevalence of inappropriate plant hosts is correlated with muted tidal regimes (Grewell et al. 2003, 2004). (USFWS, 2009)

**Stressor:** Chronic pollution (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oil spills and chronic pollution from point and non-point sources are unavoidable occurrences that continue to occur in or near habitat for Cordylanthus mollis ssp. mollis (U.S. Fish and Wildlife Service 2007). In particular, because of their location, Point Pinole and BSRA populations are the most threatened by oil spills and pollution (U.S. Fish and Wildlife Service 2006). (USFWS, 2009)

**Stressor:** Cattle grazing and feral hogs (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cattle grazing still occurs and introduced feral hogs (Sus scrofa) roam Cordylanthus mollis ssp. mollis habitat in some locations (Grewell et al. 2003). Cattle and feral hogs can degrade habitat for the species by trampling and can also damage the plant itself by crushing fragile underground connections (haustoria) to host plants. These connections are critical to the hemiparasitic life history of C. mollis ssp. mollis. In fact, the Rush Ranch population described in the final listing rule was extirpated due to trampling by cattle around 1999 (Grewell, in litt. 2008). Populations at Hill Slough and Rush Ranch (the reintroduced population) are currently subject to rooting, wallowing, trampling, and grazing impacts from livestock and feral hogs that could result in damage or loss to C. mollis ssp. mollis populations or soil disturbance and compaction leading to a disruption in natural marsh ecosystem processes (U.S. Fish and Wildlife Service 2006). (USFWS, 2009)

**Stressor:** Random events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, fire, oil spills, genetic or demographic problems or a combination of these events. (USFWS, 2009)

**Stressor:** Hybridization (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** No new information exists regarding the threat of hybridization with Cordylanthus mollis ssp. hispidus, so we must assume the threat is still present. Also, though a permitted reintroduction effort involving seed harvesting and planting has been conducted (Grewell et. al. 2003), no new information exists regarding the threat of unpermitted seed harvesting and planting. We must also assume this threat still persists. (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. The minimum area inhabited annually by the species in the Suisun Bay Area Recovery Unit must be 3,000 acres and the minimum area inhabited annually by the species around San Pablo Bay Recovery Unit must be 1,000 acres, over a period of five years. (USFWS, 2013)

2. A minimum of 5,000 acres of suitable habitat in the Suisun Bay Area and San Pablo Bay Recovery Units must be permanently preserved and under protective management. (USFWS, 2013)

3. Reduction in extant Lepidium latifolium populations in tidal areas (in and downgradient of the high marsh-upland ecotone) to less than ten percent cover for five years. (USFWS, 2013)

4. There must be less than ten percent total cover of other non-native, invasive perennial or non-native winter annual grass species (other than Lepidium latifolium), including, but not limited to, Apium graveolens (celery), Cotula coronipfolia (brass-buttons), Juncus gerardi (black-grass rush), Spartina patens (salt-meadow cordgrass), Polypogon monspeliensis (annual beard grass), Hainardia cylindrical (barbgrass), Parapholis incurva (sicklegrass), Crypsis schoenoides (swamp grass), and Lepidium latifolium within 50 feet of extant C. molle ssp. molle populations. (USFWS, 2013)

5. Natural tidal range must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic tidal flooding. (USFWS, 2013)

6. At least nine populations must occur in the Suisun Bay Area Recovery Unit and at least four populations must occur around San Pablo Bay Recovery Unit. (USFWS, 2013)

7. Over five years of monitoring, each population must have a mean of at least 3,000 individuals. (USFWS, 2013)

8. The entire species must not fall below 500 individuals for two consecutive years over a period of five years. (USFWS, 2013)

9. There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant. (USFWS, 2013)

Recovery Priority Number: 9C

**Delisting Criteria:**
1. The minimum area inhabited annually by the species in the Suisun Bay Area Recovery Unit must be 6,000 acres and the minimum area inhabited annually by the species around San Pablo Bay Recovery Unit must be 2,500 acres over a period of eight years. (USFWS, 2013)

2. A minimum of 9,000 acres in the Suisun Bay Area Recovery Unit or around San Pablo Bay Recovery Unit must be permanently preserved and under protective management. (USFWS, 2013)

3. All conditions under downlisting criterion A/3 have been met. In addition, a plan must be developed and implemented for early detection and control of Lepidium latifolium following any future increase beyond ten percent cover in tidal areas (in and down-gradient of the high marsh-upland ecotone). Also, a funding source must be secured to fund such actions in perpetuity. (USFWS, 2013)

4. All conditions under downlisting criterion number 4 must have been met. (USFWS, 2013)

5. All conditions under downlisting criterion number 5 must have been met. (USFWS, 2013)

6. Trampling damage by grazed cattle and feral pigs to C. molle ssp. molle and its haustorial connections to host plants must have been eliminated at all populations for eight years. (USFWS, 2013)

7. Reliable propagation and reintroduction methods must be developed and available. (USFWS, 2013)

8. Pre-dispersal seed predation on C. molle ssp. molle from moth larvae (Saphenista spp., Tortricidae and salt marsh snout moth, Lipographis fenestrella, Pyralidae) must, on average, fall below 15 percent. (USFWS, 2013)

9. At least ten separate populations must occur in the Suisun Bay Area Recovery Unit and at least eight separate populations must occur around San Pablo Bay Recovery Unit. (USFWS, 2013)

10. Over eight years of monitoring, each population must have a mean of at least 3,000 individuals; or if the species is widespread and abundant and is not divisible into separate populations, there must be a mean of at least 300,000 individuals in the Suisun Bay Area Recovery Unit and at least 300,000 individuals around San Pablo Bay Recovery Unit over a period of eight years. (USFWS, 2013)

11. The entire species must not fall below 1,000 individuals for two consecutive years over a period of eight years. (USFWS, 2013)

12. There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant. (USFWS, 2013)

13. Seed banking of all extant populations and representative genetic diversity (per commonly accepted seed banking protocols) must be complete. (USFWS, 2013)

14. To minimize impacts sustained after oil spills occurring at or near populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of C. molle ssp. molle. (USFWS, 2013)

15. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. (USFWS, 2013)

**Recovery Actions:**

- Non-native plant control should target Lepidium latifolium at Hill Slough, Rush Ranch, BSRA, and other population locations. (USFWS, 2013)
- Adaptive management for and monitoring of ground-nesting and other native bees, particularly near C. molle ssp. molle populations, is needed. Protection of predatory wasps that feed on moth larvae infesting C. molle ssp. molle inflorescences should reduce losses of reproductive output to seed-eaters. (USFWS, 2013)
- Management of grazing should aim to reduce trampling and breaking of haustorial connections to host plants due to disturbance. (USFWS, 2013)
- Controls should be erected and maintained to prevent illicit off-road vehicle use in habitat of C. molle ssp. molle. (USFWS, 2013)
- Where urban runoff has displaced former tidal marsh habitat at BSRA with freshwater emergent marsh, solutions should be identified to direct the runoff away from sensitive habitat. (USFWS, 2013)
- Natural tidal range should be maintained or restored, since their resulting effects on vegetation and soil chemistry are important to the persistence of C. molle ssp. molle. (USFWS, 2013)
- Seed banking is recommended for C. molle ssp. molle, including banking from different population areas. (USFWS, 2013)
- In addition to monitoring needed for appropriate management and tracking of progress toward recovery, it is recommended that field surveys be conducted for additional, as-yet undiscovered populations of C. molle ssp. molle. (USFWS, 2013)
- Given the importance of a host plant community comprised of a matrix of native perennials, information on host plants within C. molle ssp. molle population patches should also be gathered. (USFWS, 2013)
- Research is needed on many aspects of life history and conservation of C. molle ssp. molle. (USFWS, 2013)
- Over the longer term, restoration of suitable tidal marsh habitat and introduction/ reintroduction of C. molle ssp. molle within its historic range will advance recovery of the species. (USFWS, 2013)
- A recovery plan for Cordylanthus mollis ssp. mollis should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft recovery plan for this species and five other listed tidal marsh species is currently in development at SFWO. (USFWS, 2009)
- Control of non-native competitor species and non-native winter annual species should be conducted at all appropriate sites. Lepidium latifolium should be targeted at Hill Slough Wildlife Area, Rush Ranch, BSRA, and other population locations where it presents a threat and Spartina patens (salt-meadow cord grass) should be targeted at BSRA. Nonnative winter annuals that invade upper tidal marsh habitats at the known locations should be controlled to increase survival of Cordylanthus mollis ssp. mollis seedlings (Grewell et al. 2003). Initially, surveys for these invasive plants should occur at each site in order to document the extent of spread and prioritize treatment efforts. (USFWS, 2009)
- Natural tidal cycles of San Pablo and Suisun Bays should be maintained or restored to the extent possible because middle to high marsh areas with periodic tidal flooding provide appropriate hydrology and help retain the healthy extent and composition of tidal marsh communities, including Cordylanthus mollis ssp. mollis. Additionally, natural tidal regimes encourage low abundance of damaging non-native winter annuals and seed predators. (USFWS, 2009)

- Surveys should be conducted within potential Cordylanthus mollis ssp. mollis habitat as well as at known population centers to identify potential new occurrences as well as to provide an updated species status with which to make management decisions. (USFWS, 2009)
- Management of Cordylanthus mollis ssp. mollis habitat should involve reducing trampling and breaking of haustorial connections to host plants by grazed cattle and feral hogs. Removal of cattle and feral hogs or other protection of the populations from grazing should occur at Hill Slough and Rush Ranch populations, as well as other locations where trampling presents a threat to C. mollis ssp. mollis. A regional-scale feral hog eradication effort should be coordinated with CDFG to decrease that species' impact on habitat for sensitive plants. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations for future actions are based on the Service's Recovery Plan (2013) and incorporation of recent research and findings, such as the USGS' 2021 range wide survey and genomics study in Chloropyron molle ssp. molle. Surveying and Monitoring: • Recovery Actions A/1, A/2. Develop and implement an annual, range wide survey and monitoring plan for Chloropyron molle ssp. molle. As population sizes of C. molle ssp. molle can fluctuate dramatically between years, surveys that attempt near-exact counts rather than abundance estimates of populations should be the primary focus. Special attention should be given to acquire exact counts, annually, of the populations at regularly inhabited sites. Surveys should also include: the number and location of populations; estimates of area inhabited by each population. • Recovery Actions A/3, A/4. Work with partners to develop and implement a survey and monitoring plan for invasive species in areas inhabited by Chloropyron molle ssp. molle. Surveys should be focused on populations of Chloropyron molle ssp. molle and areas within 50 ft. of each population and they should be conducted based on the development and phenology of the identified invasive plants. These surveys should include: the location of the areas surveyed; survey frequency; invasive plants of interest at each site; abundance estimates of invasive plants found; and proximity to nearest population of C. molle ssp. molle. Known invasive plant threats currently include but might not be limited to: Lepidium latifolium, Hainardia cylindrica, Polypogon mospeliensis, Cotula coronopifolia. Cuscuta salina is native to the Bay-Delta, however, it should be included in such surveys based on the predicted inappropriate plant-host relationship it can form with C. molle ssp. molle. Survey follow-up and monitoring records should include information on historical, ongoing, and/or planned invasive mitigation and eradication techniques in collaboration with partners. • Recovery Action A/6. Develop and implement a survey and monitoring plan to focus on trampling and rooting damage by livestock and feral pigs to Chloropyron molle ssp. molle populations. This plan should cover how to monitor damage, the partners and groups responsible for organizing and conducting surveys and monitoring, the locations to be surveyed and monitored, and the frequency at which surveys/monitoring are needed. Restoration Activities: • Recovery Action A5. Develop a plan to restore tidal marsh, including restoration of periodic tidal flooding at Hill Slough and Rush Ranch pond areas. Complete the actions that are achievable within 5 years. Follow-up with a monitoring plan of tidal flooding at Hill Slough and Rush Ranch pond areas. • Recovery Action A/7. Renew efforts and advance methods for propagation, including a plan to scale-up propagation, of C. molle ssp. molle to be used in restoration and reintroduction / mitigation efforts. • Recovery Actions E/1d, E2. Develop and implement a seed banking plan for C. molle ssp. molle including development of seed storage protocol with estimates of storage effects on seed viability/longevity. Seed collection and banking efforts should be developed based in-part on current knowledge of the range wide distribution of genetic diversity. • Develop a plan to reintroduce 1-2 populations of C. molle ssp. molle that might serve as connector populations to promote gene flow between Fagan Marsh and Point Pinole populations in the west and all other populations of C molle ssp. molle in the eastern portion of the range. This plan should incorporate information from the USGS' 2021 range wide survey of sites with potentially suitable habitat, as well as in-depth surveys of all existing public lands in the area for currently unknown sites of potentially suitable habitat. Source material for reintroductions should also rely on genotypic information and diversity estimates from the 2021 USGS study. Additional Future Actions for Consideration: • Genetic monitoring of populations, particularly those that appear to be at-risk of intraspecific hybridization with Chloropyron molle ssp. hispidum, and the western-most isolated populations at Fagan Marsh and Point Pinole that appear to be experiencing restricted gene flow. • Breeding trials between Chloropyron molle ssp. molle and C. molle ssp. hispidum to determine what level of threat intraspecific hybridization poses in the northeastern portion of C. molle ssp. molle's range. • Investigation(s) into seed ecology of C. molle ssp. molle to support seed banking efforts and to inform on the potential use of direct-seeding in restorations. • Investigation(s) into plant-pollinator relationships to inform on reproductive biology of C. molle ssp. molle and to aid in making predictions regarding current and future gene flow across the species range. • Quantitative genetics studies to estimate species' phenotypic plasticity (i.e., the capacity to respond to changing environmental conditions) especially to variation in hydrological factors. • Studies focused on the C. molle ssp. molle's plant-host relationships to better determine potential risk from inappropriate host relationships. • Conduct public outreach and education to develop potential partnerships with private landowners with property where C. molle ssp. molle might be present (USFWS, 2023).

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# SPECIES ACCOUNT: *Cordylanthus palmatus* (Palmate-bracted bird's beak)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/01/1986; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

An annual herb in the broomrape family (Orobanchaceae) (Olmstead et al. 2001). The plants are 4-12 inches tall and highly branched. The stems and leaves are grayish green and sometimes are covered with salt crystals excreted by glandular hairs. Small pale whitish flowers, up to 1-inch long, are arranged in dense clusters (spikes) and are densely surrounded by herbaceous leaf-like bracts. The petals are divided into two lips. The upper one is shaped like a bird's-beak, leading to the common name of the genus. (USFWS, 2009)

**Taxonomy**

Tank et al. (2009) moved four species of Cordylanthus (maritimus, mollis, palmatus, and tecopensis) to Chloropyron. (NatureServe, 2015)

**Historical Range**

Historically, the species is known from scattered locations in the Sacramento and San Joaquin Valleys (Bittman 1985, 1986; Center for Conservation Biology 1991, 1992, 1993, 1994) (USFWS, 2009)

**Current Range**

The species ranges from the northern Sacramento Valley south to the San Joaquin Valley. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 2009)

**Dependency on Other Individuals or Species**

Adult: Bumblebees (Bombus californicus, B. occidentalis, and B. vosnesenskii) were the primary pollinators of palmate-bracted bird’s-beak at the Springtown Alkali Sink in 1993. (USFWS, 1998)

**Breeding Season**

Adult: May to October (USFWS, 1998

**Key Resources Needed for Breeding**

Adult: Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993).

**Reproduction Narrative**

Adult: Palmate-bracted bird's-beak is an annual herb in the broomrape family (Orobanchaceae) (Olmstead et al. 2001). This species flowers from May until October (Skinner and Pavlik 1994). Both self- and cross-pollination can contribute to seed-set (Center for Conservation Biology 1993j, and individual plants can produce up to 1.000 seeds in a single growing season (Center for Conservation Biology 1991). Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993). Bumblebees (Bombus californicus, B. occidentalis, and B. vosnesenskii) were the primary pollinators of palmate-bracted bird's-beak at the Springtown Alkali Sink in 1993. (USFWS, 1998; USFWS, 2009)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland/herbaceous, Shrubland/chaparral (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Seasonal flooding (USFWS, 1998)

**Geographic or Habitat Restraints or Barriers**

Adult: Restricted to elevations of less than 155 m (500 feet) (USFWS, 1998)

**Spatial Arrangements of the Population**

Adult: Small and isolated patches (USFWS, 2009)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 2009)

**Habitat Narrative**

Adult: Palmate-bracted bird's-beak is restricted to seasonally-flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet). It occurs in a mosaic pattern of small and isolated patches. Within these areas, palmate-bracted bird's-beak grows primarily along the edges of channels and drainages, with a few individuals scattered in seasonally-wet depressions, alkali scalds (barren areas with a surface crust of salts), and grassy areas. Suitability of microhabitats for palmate—bracted bird's beak depends primarily on soiI pH and to a lesser extent on soil layering, salinity, and moisture. This species occurs on neutral to alkaline soils pH 7.2 to 9.5) under natural conditions (Coats et al. 1993, Center for Conservation Biology 1993, 1994). (USFWS, 1998; USFWS, 2009)

***Dispersal/Migration***

**Dispersal**

Adult: Moderate (inferred from USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: The pattern of genetic variation within palmate-bracted bird's-beak populations support the hypothesis that the historical frequency and extent of seed dispersal by overland flooding has influenced population genetic structure. In brief: (1) sites that are more-frequently flooded or that have more extensive floods (leading to enhanced seed dispersal). (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2009)

**Number of Populations:**

7 (USFWS, 2023)

**Additional Population-level Information:**

Historically, palmate-bracted bird's-beak was documented at nine sites between 1916 and 1982 (in Alameda, Colusa, Fresno, Madera, San Joaquin, and Yolo Counties), but only three were known to be extant at the time the species was listed in 1986: two natural populations (Springtown Alkali Sink and southeast of Woodland, which is now known as Alkali Grasslands Preserve) and one transplanted population (Mendota Wildlife Area) (Service 1986, p. 23767). As of our 2009 status review, the species was known to occurr as a mosaic of small, isolated patches on approximately 1,500 acres of occupied habitat at eight sites ranging from the northern Sacramento Valley south to the San Joaquin Valley (Sacramento, Colusa, and Delevan National Wildlife Refuges (collectively referred to as the Refuges); Alkali Grasslands Preserve; Springtown Alkali Sink; Western Madera County; Alkali Sink Ecological Reserve; and Mendota Wildlife Area) (Service 2009, p. 20). The Sacramento Refuge population was introduced in 1990 (Service 1998, p. 35); additional sites were located through intensive survey efforts. There have been few changes in the distribution of palmate-bracted bird's-beak since our 2009 status review. The population in Western Madera County is likely extirpated based on recent vernal pool mapping showing that the four occurrences were disked and later converted to agriculture (Witham 2021, unpaginated geodatabase). In addition, no new information is available for the Mendota Wildlife Area population, which may have been extirpated by changing conditions prior to the 2009 status review (USFWS, 2023).

**Population Narrative:**

The palmate-bracted bird's-beak has declined significantly over the past century. Several palmate-bracted bird's-beak species experts have suggested that (a) except, perhaps, for Sacramento National Wildlife Refuge Complex there are fewer palmate-bracted bird's-beak today than when the species was originally listed and (b) population trends are down. Of the eight known occurrences (up to 10 populations reported historically), five are located on public lands and are protected from development. The constrained dispersal abilities of C. palmatus can limit its ability to withstand changes in climate. (USFWS, 2009)

***Threats and Stressors***

**Stressor:** Urban sprawl (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Urban sprawl and associated human activities have also been identified as the leading cause of species imperilment – including the palmate bracted bird's-beak -- in the State (National Wildlife Federation 2001). Sprawl (low density, automobile dependent development into natural areas outside of cities and towns) results in habitat loss, habitat degradation (including the disruption of natural processes, wildfire suppression, noise pollution, and high-impact outdoor recreation), habitat fragmentation (including blocking wildlife movement and edge effect), and loss of species diversity (including an increase in exotic species and changing ecosystem dynamics). (USFWS, 2009)

**Stressor:** Habitat loss (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** These widespread and ongoing threats include: the conversion of native habitat into irrigated agricultural fields (e.g., palmate-bracted bird's-beak sites at Woodland, Sacramento Valley, San Joaquin Valley); installation of pipelines and transmissions lines (Woodland); drainage facilities (Springtown residential development); gas and water pipelines (Springtown); and off-road vehicle use (Springtown). (USFWS, 2009)

**Stressor:** Cattle grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, cattle grazing was identified as a major factor (Service 1986:23767). Cattle grazing has undoubtedly altered the plant species composition of the areas occupied by the palmate-bracted bird's-beak, but the specific effects and mechanisms were not indicated. Existing grazing levels, at that time, did not appear to threaten those areas still supporting the palmate-bracted bird's-beak. Cattle grazing as a management tool, it now appears, can be beneficial as well as harmful to the palmate-bracted bird's-beak. Grazing can enhance the conservation status of the palmate-bracted bird's-beak through the removal of invasive non-native plants that compete with the palmate-bracted bird's-beak for resources or displace host plants (Wingo-Tussing et al., 2005; Wingo-Tussing 2006). (USFWS, 2009)

**Stressor:** Invasive non-native plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive non-native plant species are a potential threat to palmate-bracted bird's-beak and associated native host plants at Colusa NWR and Delevan NWR (Wight 2000; Wingo-Tussing et al. 2005; WingoTussing 2006). Populations of the annual ryegrass (Lolium multiflorum), tall wheatgrass (Elytrigia pontica ssp. pontica), broad-leaved pepperweed (Lepidium latifolium), and fleshy-leaved Russian-thistle (Salsola soda) have been increasing in habitat occupied by palmate-bracted bird's-beak, and associated (host) plants such as Great Valley gum plant (Grindelia camporum var. camporum), pappose spikeweed (Hemizonia parryi spp. rudis), alkali heath (Frankenia salina), and saltgrass (Distichlis spicata; host plant). These plants compete with the palmate bracted bird's-beak for resources (e.g., space, water, and nutrients) and can displace host plants. (USFWS, 2009)

**Stressor:** Accidental flooding (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Accidental flooding of palmate-bracted bird's-beak during the dry period (June to September) from rice field run-off has also impacted one palmate bracted bird's beak patch at Colusa NWR (J. Silveira, in litt., 2006). Extensive and unseasonal flooding can kill palmate-bracted bird's-beak plants, as well as allow other plants to invade after the waters recede. Deep flooding that persists over several weeks can kill individual plants. (USFWS, 2009)

**Stressor:** Decline of pollinators (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Another widespread threat to palmate-bracted bird's-beak is the loss of pollinators through the spraying of malathion and other pesticides. Bees are important pollinators of the palmate-bracted bird's-beak in California (SaulGershenz et al., 2004). Malathion application to bees and the vegetation where they occur may be a specific threat to the genetic diversity of palmate-bracted bird's-beak by reducing pollination. The effects of malathion application are extremely local given that bees typically range only about 300-400 meters (about 980-1300 feet) from the nest to a flower (Kroodsma 1975; Keasar et al., 1996; Capaldi et al., 2000; Kwak 2002). (USFWS, 2009)

**Stressor:** Pesticides (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Sacramento/Yolo Mosquito Vector Control District (Undated) also has an ongoing program to control the West Nile virus through the aerial application of pyrethroids and other insecticides that may affect palmate-bracted bird's-beak pollinators. It is not clear if sites with palmate-bracted bird's-beak are being sprayed or if palmate-bracted bird's-beak pollinators are being affected.

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Due to the highly restricted range of palmate-bracted bird's beak, climate change in the Central Valley could have a particularly negative effect on the species. As stated previously, the palmate-bracted bird's-beak is restricted to the Sacramento Valley and the San Joaquin Valley under a unique set of geographic (flat) and climatic (hot and dry) conditions (Figures 1-3). The range of palmate-bracted bird's-beak is restricted by soil type (alkaline-saline). Some climate change models predict for California an overall warming of 1.7 degrees Centigrade – 5.8 degrees by 2100 (Cayan et al. 2006), but they vary in their predictions for precipitation. VanRheenen et al. (2004) predict a decrease in precipitation in the San Joaquin Valley. Changes in annual precipitation have a large effect on the abundance of palmate-bracted bird's-beak, as typical of desert annuals (Germano et al. 2005; Warrick 2006). (USFWS, 2009)

**Stressor:** Ozone (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Another potential threat to palmate-bracted bird's-beak is ozone due to photochemical smog. Numerous studies have documented the negative effects of ozone on plants, such as pronounced foliar injury and growth reduction (e.g., Miller 1992; Grantz and Yang 1996; Bytnerowicz 2002), but no studies have been performed specifically on palmate-bracted bird's-beak. The California Air Resources Board (2006) reported for southern portions of the San Joaquin Valley as many as 26 days per year above the national 1-hour ozone standard and as many as 116 days per year above the national 8-hour ozone standard during the period 2002 - 2005. (USFWS, 2009)

**Stressor:** Excessive dust (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An additional potential threat to the palmate-bracted bird's-beak is excessive dust. Dust may affect photosynthesis, respiration, and transpiration, as well as allow the penetration of phytotoxic gaseous pollutants (Farmer 1993). No research, however, has analyzed the effects of dust specifically on palmate-bracted bird's-beak. From 1996 – 2005, Bakersfield – in the southern portion of the San Joaquin Valley – on average surpassed the State of California 24-hour PM10 (particulate matter with an aerodynamic diameter of 10 microns or less) standard 170 days per year and surpassed the national 24-hour PM2.5 (particulate matter with an aerodynamic diameter of 2.5 microns or less) standard 16 days per year (California Air Resources Board 2006). In 2005, the primary sources of particulate matter (PM10 and PM2.5) in Kern County, for example, were farming operations, road dust, and fugitive windblown dust (California Air Resources Board 2006). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. Protection of occupied habitat A) 95 percent of occupied habitat on public lands is secured and protected, and B) 75 percent or more of the population at Springtown Alkali Sink and 75 percent or more of the occupied area and upland habitat for pollinators within 300 meters (984 feet) of the population margins is secured and protected, and C) Two or more populations are secured and protected in the San Joaquin Valley. (USFWS, 2009)

2. A management plan that includes the survival of palmate-bracted bird's-beak as an objective has been approved and implemented for all protected areas identified as important to continued survival. (USFWS, 2009)

3. The populations are stable or increasing through a precipitation cycle. (USFWS, 2009)

**Delisting Criteria:**
1. Eight or more distinct populations, including two or more in the San Joaquin Valley are secured and protected. (USFWS, 2009)

2. 95 percent or more of the occupied habitat [under Service ownership] of Colusa National Wildlife Refuge, Delevan National Wildlife Refuge, and Sacramento National Wildlife Refuge is secured and protected. (USFWS, 2009)

3. 95 percent or more of the occupied habitat [under CDFG ownership] of the Alkali Sink Ecological Reserve-Mendota Wildlife Area (San Joaquin Valley) is secured and protected. (USFWS, 2009)

4. 260 hectares (640 acres) or more of any occupied habitat [under any ownership] elsewhere in the San Joaquin Valley, including western Madera County, is secured and protected. (USFWS, 2009)

5. 90 percent or more of the plants and occupied habitat [under ownership by City of Livermore, Federal Communications Commission, or private] of the Springtown Alkali Sink is secured and protected. (USFWS, 2009)

6. Two or more distinct populations each about 260 hectares (640 acres) [under any ownership] in the Sacramento Valley are protected. (USFWS, 2009)

7. A management plan has been approved and implemented for all protected areas identified as important to the continued survival of the species. (USFWS, 2009)

8. There is no decline after downlisting.  If the population is declining, then the Service should determine the cause and reverse the trend. (USFWS, 2009)

**Recovery Actions:**
- Recovery actions are not available.
- Protection of palmate-bracted bird’s-beak habitat on private lands. One of the most important goals for the conservation of this species is the protection of occupied palmate-bracted bird’s-beak habitat primarily at three sites. (USFWS, 2009)
- General and applied ecological research of palmate-bracted bird’s-beak. Little is known about the basic biology of this species or how it responds to management practices (C. Feldheim, in litt., 2007). (USFWS, 2009)
- Over the next 5 years, genetic variation at the remaining sites should be characterized and synthesized with existing knowledge.  The genetic variation at all sites should then be compared leading to a ranking of sites to guide conservation efforts according to the nature and extent of differences, as well as the importance of rare or unique alleles.  A seed collection, based on the site rankings, should also be completed. (USFWS, 2009)
- Natural resource managers should consider the negative impacts of invasive nonnative species in order to enhance conservation and restoration programs for the palmate-bracted bird’s-beak. Controlled grazing (see Wingo-Tussing et al. 2005; Wingo-Tussing 2006) and controlled burns (see Wight 2000) may enhance the conservation status of the palmate-bracted bird’s-beak. (USFWS, 2009)
- The continued survival of the palmate-bracted bird’s-beak depends on many demographic factors.  The natural variation of these factors, though, is poorly understood (Fleishman et al., 1994, 1996).  An outline for future actions that incorporates demographic monitoring of the several populations and minimum levels of demographic parameters maintained should

be established. (USFWS, 2009)
- The scientific name should formally be changed in the Code of Federal Regulations from Cordylanthus palmatus to Chloropyron palmatum.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the palmate-bracted bird's-beak. Some of these recommendations have already been discussed in our previous status review (Service 2009, pp. 37–39) and remain valid. 1. Conduct surveys at known occurrences to monitor population trends and habitat changes, including occurrences that are likely extirpated in Madera County and Mendota Wildlife Area to confirm status. 2. Pursue protection of the Springtown Alkali Sink and Woodland Regional Park occurrences through conservation easements and map the net occupied area of these populations. 3. Review existing management plans and revise them to include an objective for survival of palmate-bracted bird's-beak if this objective is missing. 4. Determine the most effective methods for controlling invasive non-native species at sites where palmate-bracted bird's-beak occurs and ensure the results are shared with land managers. 5. Consider historical hydrologic connection within populations to maintain genetic variation when collecting and distributing seed. Genetic isolation of populations occurring in vernal pools in the same locality should be maintained. However, seed should be collected and distributed from throughout the population where historical overland flow has been impeded by manmade barriers. 6. Evaluate the need for additional re-introductions and the effectiveness of seeding methods currently employed at the Alkali Grasslands Preserve. 7. Change the scientific name in the Code of Federal Regulations from Cordylanthus palmatus to Chloropyron palmatum (USFWS, 2023).

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# SPECIES ACCOUNT: *Cordylanthus tenuis ssp. capillaris* (Pennell's bird's-beak)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/06/1995; California/Nevada (Region 8)

**Physical Description**

A branching herbaceous annual of the broomrape family (Orobanchaceae). The plant grows 30 to 60 centimeters (12 to 24 inches) tall, with yellow-green hairless herbage that becomes purplish with age. The leaves are entire (with smooth edges), or those of the primary stem three-parted, and threadlike. The floral bracts are three-parted up to two-thirds of their length, with fine marginal hairs on bracts and calyx (collective term for the sepals or outermost whorl of flower parts). The tubular corolla (collective term for all the petals) is 1.5 centimeters (0.6 inch) long (Chuang and Heckard 1986), and gamet-brown laterally, paler dorsally (Pennell 1950). Each capsule contains 10 to 16 seeds (Chuang and Heckard 1986). (USFWS, 1998; USFWS, 2019b)

**Taxonomy**

Cordylanthus capillaris (Pennell’s bird’s-beak) was first described by Pennell (1950). Chuang and Heckard (1986) reclassified the Cordylanthus genus and considered Pennell’s bird’s-beak to be a subspecies: C. tenuis ssp. capillaris. At the time of listing, the genus was considered within the snapdragon family (Scrophulariaceae). Presently, the genus Cordylanthus is considered within the broomrape family (Orobanchaceae) (Olmstead et al. 2001). (USFWS, 2011)

**Historical Range**

Known only from the Outer North Coast Ranges floristic province of Sonoma County, California, a range of a few square miles (vicinity of unincorporated Camp Meeker area). (USFWS, 2019b)

**Current Range**

Known only from the Outer North Coast Ranges floristic province of Sonoma County, California, a range of a few square miles (vicinity of unincorporated Camp Meeker area). (USFWS, 2019b)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (self-incompatible) (USFWS, 2011)

**Lifespan**

Adult: 1 year (USFWS, 2011)

**Dependency on Other Individuals or Species**

Adult: Members of the Cordylanthus genus require bees for effective pollination (Chuang and Heckard 1986).

**Breeding Season**

Adult: June to July (USFWS, 2011)

**Reproduction Narrative**

Adult: Pennell's bird's-beak is an herbaceous annual of the broomrape family (Orobanchaceae) (Olmstead et al. 2001) and it flowers from June through July (Chuang and Heckard 1986). Members of the Cordylanthus genus require bees for effective pollination (Chuang and Heckard 1986). The fruit are capsules containing 10 to 16 seeds (Chuang and Heckard 1986). C. tenuis ssp. capillaris were found to be self-incompatible (Chuang and Heckard 1986). Members of the bird's-beak group require bees for effective pollination (Chuang and Heckard 1986). (USFWS, 2019b)

**Habitat Type**

Adult: Terrestrial (USFWS, 2011)

**Habitat Vegetation or Surface Water Classification**

Adult: Chaparral communities (USFWS, 2011)

**Geographic or Habitat Restraints or Barriers**

Adult: Restricted to elevations from 45 to 245 meters (148 to 804 feet) (USFWS, 2011)

**Spatial Arrangements of the Population**

Adult: Colonies (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2011)

**Habitat Narrative**

Adult: Cordylanthus tenuis ssp. capillaris grows only on serpentine soils among chaparral and closed pine forests (Chuang and Heckard 1986) and are found in colonies. Occurrences range in elevation above mean sea level from 45 to 245 meters (148 to 804 feet) (Calflora 2011, CNPS 2011). Cordylanthus tenuis ssp. capillaris is associated with Sargent's cypress (Cupressus sargentii), Baker's manzanita, and coffeeberry (Rhamnus californica) (Chuang and Heckard 1986). (USFWS, 2011)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019a)

**Number of Populations:**

4 (USFWS, 2024)

**Population Size:**

Unknown; fluctuates from well over 10,000 to a few individuals at each location (USFWS, 2024)

**Population Narrative:**

In 2011, Pennell’s bird’s-beak was recognized to occur in five separate locations (USFWS 2011). Currently, Pennell’s bird’s-beak is known from four locations (CNDDB 2018). California Natural Diversity Database lists occurrence #1 as mainly within the Harrison Grade Ecological Reserve, owned and managed by CDFW. The fifth occurrence is combined with occurrence #4. Two occurrences (#2 and #4) are within what is now the Bohemia Ecological Preserve. This property is protected under a conservation easement, which is owned and managed by Land Paths since 2012 (E. Mullen, pers. comm. 2018). Occurrence #3 is located on the privately owned Twin Valley Ranch near Porter Creek, about 11 kilometers (6.8 miles) northeast of occurrence #2. However, this site has not been surveyed in the past 20 years. While the status of this population remains unknown, it is assumed to be extant. Anecdotal reports suggest many Pennell’s bird’s-beak populations exist on private property outside of the before mentioned occurrences in areas where botanical surveys have not been done (G. Cooley, pers. comm. 2018). Biologists with CDFW have observed Pennell’s bird’s-beak on private properties outside of the reserve boundaries at the Harrison Grade Ecological Reserve (J. Bjerke, in litt. 2018b). The full extent of the population remains unknown. (USFWS, 2019a). At the time of listing in 1995, Pennell’s bird’s-beak was documented at two locations near one another (Service 1995, p. 6673): one on Bohemian Highway and the other partially within the Harrison Grade Ecological Reserve. Little has changed since our 2019 status review where the species was known from four locations (Service 2019a, p. 2). There are two occurrences within the Bohemia Ecological Preserve, which is still managed by LandPaths; one on Harrison Grade Ecological Reserve, owned and managed by the Department; and one assumed to be extant on privately owned lands near Porter Creek that has not been surveyed since it was identified in 1997 (Diversity Database, entire). In addition, there are some plants at the Regional Parks Botanic Garden located in Berkeley, California (California Plant Rescue 2023, entire). Seed was also collected in 2005 and is stored in Claremont, California (California Botanic Garden 2024, entire; Service 2011, p. 15). Abundance: Pennell’s bird’s-beak is an annual plant with population sizes that can vary greatly (Service 1995, p. 6673; Service 2011, p. 5; Service 2019, p. 2). A small population size one year can be followed by a much larger one the following year when conditions are optimal. This makes population trends difficult to detect. Moreover, population sizes are not consistently estimated, and it is rare that they are estimated in consecutive years. Numeric estimates of individual populations exist for only nine years between 1981 and 2018. These have occurred most often at Harrison Grade Ecological Reserve, which was counted six years in that time period. It also has the highest number of plants recorded with more than 10,000 in 1981 (Diversity Database p. 3); more recently, the highest population estimate there was in 2009 with thousands observed (Diversity Database, p. 3). (USFWS, 2024)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2011)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** At the time of listing, development and associated road construction on the private lands containing occurrence 1, which would result in loss, modification, and destruction of Cordylanthus tenuis ssp. capillaris habitat, were considered potential threats. Development plans had included the donation of 87 hectares (including C. tenuis ssp. capillaris habitat) to the county for use as a park (Service 1998). However, although some roads were constructed, the development never took place, and the land was subsequently sold. Habitat for Cordylanthus tenuis ssp. capillaris along Bohemian Highway has been significantly reduced within the past 23 years (Herrick, in litt. 2011). Parts of the talus and bank have been removed and a windrow has been planted in areas known to be previously colonized by C. tenuis ssp. capillaris (Herrick, in litt. 2011). (USFWS, 2011)

**Stressor:** Vineyards (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Presently, within the past 5 to 10 years along Stoetz Lane parcels of land have been converted vineyards. The conversion to vineyards of potential C. tenuis ssp. capillaris habitat continues to threaten populations at CNDDB occurrence 2 (Herrick, in litt. 2011). (USFWS, 2011)

**Stressor:** Timber harvest (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** CNDDB Occurrence 1 is located on property where timber harvesting has occurred since the time of listing (G. Hale, Sonoma Land Trust, in litt. 2011). Similarly, timber harvesting has occurred on the property where Occurrence 6 is located, and may continue in the future (Robertson 2011, Zito 2011). Timber harvesting can cause significant changes in the species richness and diversity in the herbaceous plant layer (Battles et al. 2001, Macdonald and Fenniak 2007). Although some effects of canopy removal can be short-lived, many other effects persist over a much longer timeframe (e.g., disturbance-mediated limitations to dispersal) (Gilliam 2007). Such effects could be detrimental to populations of C. tenuis ssp. capillaris. Roadside maintenance such as mowing has been reported at occurrence 4, and cattle grazing was reported at occurrence 5 (CNDDB 2011). (USFWS, 2011)

**Stressor:** Mowing and grazing (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mowing and grazing before the plants flower, typically June through July (Chuang and Heckard 1986) would prevent the generation of seeds. As an annual herbaceous plant species, C. tenuis ssp. capillaris relies on seed banks to maintain population levels. Horses and deer were reported to browse on Cordylanthus tenuis ssp. capillaris. The site of occurrence 5 has been used for cattle grazing (CNDDB 2011). In general, however, the number of plants damaged by grazing continues to be unknown. (USFWS, 2011)

**Stressor:** Diseases (USFWS, 2011)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Due to the hemiparasitic nature of Cordylanthus tenuis ssp. capillaris, diseases to potential host species may threaten C. tenuis ssp. capillaris populations. Phytophthora cinnamomi is a pathogen causing mortality in a number of native forests and chaparral communities in northern California (Swiecki, in litt. 2008, p. 2). Phytophthora ramorum is another pathogen known to cause sudden oak death in at least four coastal California oak species (Garbelotto et al., 2001; Rizzo and Garbelotto 2003). The Service lacks adequate information to determine the potential effects of these pathogens on Cordylanthus tenuis ssp. capillaris. (USFWS, 2011)

**Stressor:** Increasing human populations (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Increasing human populations in central California coastal counties were reported to place a great strain on undeveloped wild-lands, such as those found on the serpentine soils (Service 1995). Listed factors include pedestrian and off-road vehicle traffic, hiking and bicycle trails, and unauthorized garbage dumping. These factors can lead to increased erosion, the establishment of non-native, invasive plants, and the fragmentation of the native plant populations (Service 1995). In turn the native plant populations are increasingly susceptible to natural factors that can negatively affect viability, such as fire and disease (Brigham and Schwartz 2010). The limited number and isolated conditions of the Cordylanthus tenuis ssp. capillaris populations, resulting from these natural and manmade factors, can render the species susceptible to stochastic extinction (Brigham and Schwartz 2010). (USFWS, 2011)

**Stressor:** Roadside maintenance (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Roadside maintenance, such as mowing and spraying, and vehicular traffic were mentioned as threats to Cordylanthus tenuis ssp. capillaris in the 1995 listing (Service 1995). Unauthorized dumping of articles ranging from appliances to bottles also was mentioned as factors affecting C. tenuis ssp. capillaris (Service 1995). Whereas light road grading was thought to facilitate establishment of C. tenuis ssp. capillaris, heavy road disturbance may increase the invasion of non-native plant species (Service 1995). (USFWS, 2011)

**Stressor:** Habitat fragmentation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Leimu et al. (2006), in meta-analyses of plant studies published between 1987 and 2005, determined that the negative effects of habitat fragmentation (e.g., reduced genetic variation, increased demographic stochasticity) are more common among self-incompatible and rare plant species. Cordylanthus tenuis ssp. capillaris is not only rare, but also self-incompatible (Chuang and Heckard 1986). Although natural selection pressures have acted over time to create a niche for C. tenuis ssp. capillaris on serpentine soils, the fragmented nature of serpentine habitats can leave rare plants dependent upon them susceptible to vagaries of stochastic events

Indeed, populations of C. tenuis ssp. capillaris vary among years (CNDDB 2011), and the causes for annual variations are not readily apparent. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. (USFWS, 2011)

**Stressor:** Ozone (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Ozone due to photochemical smog is another potential threat to Cordylanthus tenuis ssp. capillaris. Several studies have documented harmful effects of increased nitrogen deposition, such as increased foliar injury and growth reduction (e.g., Miller 1992; Grantz and Yang 1996; Bytnerowicz 2002), yet no information exists specifically for C. tenuis ssp. capillaris. (USFWS, 2011)

**Stressor:** Pesticide Use (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Research analyzing the potential effects of pesticide use is becomingly increasingly important, particularly in areas where agriculture is prevalent such as the wine-growing region of Sonoma County, California. The Environmental Protection Agency (Agency) recently released the final biological evaluations assessing the effects of labeled use of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. Members of the bird's-beak group require bees for effective pollination (Chuang and Heckard 1986, p. 24). The Agency's final biological evaluations determined that all three pesticides are highly toxic to bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Pennell's bird's-beak, there is a potential for the three pesticides to indirectly adversely affect the species (Agency 2022a, pp. 4, Appendix 4-1; Agency 2022b, pp. 2, Appendix 4-1; Agency 2022c, pp. 3, Appendix 4-1). The Agency anticipates releasing amended proposed interim decisions and the Service is working on a national Section 7 consultation with the Agency (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
A minimum of five populations of Pennell's bird's-beak are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area should include occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. Occupied habitat is secured and voluntarily protected in at least five sites (or populations).

All known populations, and any occupied or unoccupied habitat identified as essential to survival, are voluntarily protected in perpetuity on parcels large enough to incorporate the spread and establishment of new colonies.

Management plan(s), approved by the Service, are implemented for all populations described in A/1 and any occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized annual monitoring of populations.

Recovery Priority Number: 6

The spread of pathogenic species that might be harmful to Pennell's bird's-beak habitat is controlled at or below a level at which a population viability analysis indicates it does not pose a threat to the persistence of the species.

Until research shows otherwise, recovery efforts will target securing protected populations containing a minimum of 2,000 individual plants each, but preferably many more.

Population trends at all sites are stable or increasing over 20 years that include two normal precipitation cycles (or longer if suggested by the results of demographic monitoring).

Impacts from plants that are non-native to serpentine habitats have been managed at levels that do not pose a threat to the persistence of Pennell's bird's-beak

Seeds representative of the breadth of the species' genetic diversity are stored in at least two Center for Plant Conservation certified facilities; seed germination, propagation, and out-p

**Delisting Criteria:**
A/1: Areas of occupied habitat are secured or established and voluntarily protected in perpetuity for at least ten known sites large enough to incorporate the seasonal and spatial variation of new colonies. Protected areas are at least 12 hectares (30 acres), unless future research indicates otherwise. (USFWS, 2019b)

A/2: The breadth of current genetic variation is represented at protected sites. (USFWS, 2019b)

A/3: No damage is recorded over the course of 20 years due to trampling or vandalism. (USFWS, 2019b)

E/1: Plants that are nonnative to serpentine habitats are monitored and controlled at a level that allows for the increase, establishment, and persistence of Pennell's bird's-beak in protected areas on suitable habitat. (USFWS, 2019b)

**Recovery Actions:**

- 1. Establish or protect additional populations of Pennell's bird's-beak. 1.1 Conduct botanical field surveys to discover additional populations. (Priority 1). 1.2 Protect additional populations through voluntary conservation agreements or land acquisitions. (Priority 1). 1.3 Collect and introduce Pennell's bird's-beak seeds in areas of appropriate habitat on protected lands. (Priority 1). 1.4 Survey reintroduction sites annually to determine abundance and extent. (Priority 2). (USFWS, 2019b)
- 2. Conduct research to increase understanding of Pennell's bird's-beak life history and annual establishment. 2.1 Conduct research to determine the full range (area and extent). of the species. (Priority 3). 2.2 Conduct demographic surveys and long-term monitoring that includes, but is not limited to, habitat surveys, genetic research, host-parasite dynamics, and annual establishment. (Priority 1). 2.3 Investigate and monitor potential management methods to maximize population success. Adapt and modify management as necessary. (Priority 2). (USFWS, 2019b)
- 3. Conduct genetic research to determine if genetically distinct populations exist outside of protected areas. (Priority 3). (USFWS, 2019b)
- 4. Monitor and manage Pennell's bird's-beak populations on protected lands. 4.1 At locations where the plant is protected, establish management plans to ensure the quality of existing habitat is maintained and/or degraded habitat is restored. (Priority 2). 4.2 Conduct regular patrols to deter illegal dumping in habitat. If needed, mitigate the 51 effects of illegal dumping on habitat. (Priority 3). 4.3 Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 4.4 Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019b)
- Until research shows otherwise, recovery should target securing populations containing a minimum of 2,000 plants each (but preferably more). The probability of population persistence over the long-term is expected to be higher for larger populations because large size decreases the likelihood of reduced viability or population extirpations due to random demographic or genetic events (Barrett and Kohn 1991, Ellstrand and Elam 1993). (USFWS, 1998)
- Protecting and managing populations at the two remaining locations by working with the California Department of Fish and Game and private landowners to ensure long-term survival of the species. Populations on private land should be protected by land acquisition, conservation easements, or other means. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150- meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In addition, other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing Cordylanthus tenuis ssp. capillaris and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized annual monitoring of Cordylanthus tenuisssp. capillaris populations to determine demographic trends. The plans should also include strategies to

minimize known threats at the sites as well as to identify new threats as they may appear. In particular, threats from off road vehicle use, dumping, and roadside maintenance must be eliminated. If new threats (e.g. invasion of non-natives) are identified or other new information becomes available, management plans need to be reevaluated and revised. (USFWS, 1998)

- Collection and banking of seed in Center for Plant Conservation certified botanic gardens is also a high priority recovery action for Cordylanthus tenuis ssp. capillaris. Seed banking is prudent to guard against extinction of the species from chance catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriations, andlor introductions to new sites. In the absence of genetic data for Cordylanthus tenuis ssp. capillaris, seed banking should include collections from all known populations. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
- Other suitable serpentine habitat should be surveyed to determine whether undiscovered populations exist. If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. (USFWS, 1998)
- Research on seed germination and propagation techniques that take into account the hemiparasitic nature of the plant, the use of burning as a management strategy, and basic research on demography (including soil seed bank) and reproduction (including mating system and pollination). Demographic research would be valuable to identify limiting life history stages. (USFWS, 1998)
- Recommended Future Action from 2011 5-Year Review: Protect known occurrences from threats by acquiring the private lands from willing sellers where Cordylanthus tenuis ssp. capillaris is known to occur. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Design and implement a comprehensive survey method for Cordylanthus tenuis ssp. capillaris. Survey designs should incorporate geographic information systems (G.I.S.) technology to identify additional suitable sites for C. tenuis ssp. capillaris. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Work with land owners and land managers to gain access to known and potential suitable sites for Cordylanthus tenuis ssp. capillaris populations. Annual population surveys of known occurrences should be reported to the CNDDB. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Scientific studies should be conducted to identify ideal host species. Chuang and Heckard (1971) have inferred suitable host species for Cordylanthus tenuis ssp. capillaris, yet individual plant fitness varies with host plant relationships. Studies remain to identify decisively the optimal host species. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Ascertain the importance of habitat disturbance to Cordylanthus tenuis ssp. capillaris. Current occurrences are openings among chaparral and conifer woodlands. Management strategies should evaluate the effectiveness of timber removal and fire ecology for the propagation of the species. (USFWS, 2011)
- Recommended Future Action from 2019 5-Year Review: Survey to identify potential habitat. A comprehensive and systematic survey of serpentine habitats for the presence of Pennell's bird's-beak has yet to be conducted. A new occurrence was discovered in 1997 during surveys for a different serpentine plant (CNDDB 2018). Anecdotal reports suggest additional populations might exist on private property. By identifying these areas and working with

local landowners, additional occurrences might be protected inperpetuity. (USFWS, 2019a)
- Recommended Future Action from 2019 5-Year Review: Conduct research to better understand Pennell's bird's-beak life history, demographics, annual establishment, etc. Very little is known about the demographics and life history of Pennell's bird's-beak. Future research should be focused on informing conservation and management decisions. Current occurrences indicate that site disturbance might promote colonization, yet the role of disturbance mechanisms such as fire and flooding is unknown. Conducting long-term 4 demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics and annual establishment would further recovery goals. (USFWS, 2019a)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Survey to identify potential habitat. A comprehensive and systematic survey of serpentine habitats for the presence of Pennell's bird's-beak has yet to be conducted. A new occurrence was discovered in 1997 during surveys for a different serpentine plant (CNDDB 2018). Anecdotal reports suggest additional populations might exist on private property. By identifying these areas and working with local landowners, additional occurrences might be protected in perpetuity. Conduct research to better understand Pennell's bird's-beak life history, demographics, annual establishment, etc. Very little is known about the demographics and life history of Pennell's bird's-beak. Future research should be focused on informing conservation and management decisions. Current occurrences indicate that site disturbance might promote colonization, yet the role of disturbance mechanisms such as fire and flooding is unknown. Conducting long-term demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics and annual establishment would further recovery goals. (USFWS, 2019a)
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of Pennell's bird's-beak. Some of these recommendations have already been discussed in our previous status review (Service 2019a, pp. 3–4) and remain valid. 1. Conduct surveys at known occurrences to monitor population trends and habitat changes. 2. Conduct a comprehensive and systematic survey of serpentine habitats to locate additional occurrences of Pennell's bird's-beak. Anecdotal reports suggest additional occurrences exist on private property. By identifying these areas and working with local landowners, these might be protected in perpetuity and contribute towards species recovery. 3. Conduct studies to evaluate and monitor potential management methods to maximize population success such as introducing disturbance through vegetation clearing or burning. Disturbance has been suggested to promote colonization yet the role of disturbance mechanisms such as fire and flooding is unknown. Understanding these mechanisms would aid in management and recovery of the species. 4. Conduct long-term demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics, and evaluation of seed germination and propagation techniques to improve annual establishment and further recovery goals. 5. Review existing management plans and revise them to include an objective for standardized monitoring of Pennell's bird's-beak if this objective is missing. Assess the need for annual and quantitative monitoring to achieve recovery objectives (USFWS, 2023).
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of Pennell's bird's-beak. Some of these recommendations have already been discussed in our previous status review (Service 2019a, pp. 3–4) and remain valid. 1. Conduct surveys at known occurrences to monitor population trends and habitat changes. 2. Conduct a comprehensive and systematic survey of serpentine habitats to locate additional occurrences of Pennell's bird's-beak. Anecdotal reports

suggest additional occurrences exist on private property. By identifying these areas and working with local landowners, these might be protected in perpetuity and contribute towards species recovery. 3. Conduct studies to evaluate and monitor potential management methods to maximize population success such as introducing disturbance through vegetation clearing or burning. Disturbance has been suggested to promote colonization yet the role of disturbance mechanisms such as fire and flooding is unknown. Understanding these mechanisms would aid in management and recovery of the species. 4. Conduct long-term demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics, and evaluation of seed germination and propagation techniques to improve annual establishment and further recovery goals. 5. Review existing management plans and revise them to include an objective for standardized monitoring of Pennell's bird's-beak if this objective is missing. Assess the need for annual and quantitative monitoring to achieve recovery objectives. (USFWS, 2024)

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# SPECIES ACCOUNT: *Coryphantha robbinsiorum* (Cochise pincushion cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 01/09/1986; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

A spiny succulent with a solitary round stem, 3-5 cm tall. Pale green-yellow flowers appear in March-April, followed in July and August by orange-red fruits (NatureServe, 2015).

**Taxonomy**

The Cochise pincushion cactus was originally named Cochiseia robbinsorum by W.H. Earle (1976). The genus Cochiseia was rejected almost immediately. Dr. A.D. Zimmerman (1978) assigned the species to the genus Coryphantha, which is currently the most frequently accepted placement. The only other synonym for the species is Escobaria robbinsorum, which is subject to an unresolved controversy (USFWS, 1993).

**Historical Range**

The Cochise pincushion cactus is known from the San Bernardino Valley, southwestern Cochise County, Arizona, and northern Sonora, Mexico (Lopresti 1984) (USFWS, 1993).

**Current Range**

It occurs in Cochise Co., Arizona and Sonora, Mexico (NatureServe, 2015). It is restricted to three small limestone hills in Cochise County, Arizona, along the U.S./Mexico border (USFWS, 2007). The Cochise pincushion cactus is known from among several Permian limestone hills in southeastern Cochise County, Arizona. Once thought to have occurred in northern Sonora, Mexico, the species has never been found in that country (USFWS,2020).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from NatureServe, 2015)

**Breeding Season**

Adult: March - April (USFWS, 2016)

**Key Resources Needed for Breeding**

Adult: Bee pollinators (USFWS, 1993)

**Reproduction Narrative**

Adult: Lower reproduction rate than most cacti - estimated average annual production is 3 fruits with 20 seeds per plant (NatureServe, 2015). Flowering begins in mid-March extending to mid-April (USFWS, 2016). Zimmerman (1985) noted the small bees Perdita opuntiae, Ashmeadiella opuntiae, and (rarely) Dialictus sp. visiting the flowers of Coryphantha robbinsorum (USFWS, 1993). At least 100 species of bees are using the Cochise pincushion cactus habitat; the rare cactus specialist bee, Macrotera parkeri, is the primary (but not the only) pollinator of Cochise pincushion cactus (USFWS, 2020).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Semidesert grassland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full sunlight (USFWS, 2007)

**Geographic or Habitat Restraints or Barriers**

Adult: 1,280 - 1,544 m elevation (USFWS, 2016); dense vegetation (inferred from USFWS, 2016)

**Spatial Arrangements of the Population**

Adult: Scattered with a few dense clumps (USFWS, 2007)

**Environmental Specificity**

Adult: The Cochise pincushion cactus is known from among several Permian limestone hills in southeastern Cochise County, Arizona (USFWS, 2020).

**Dependency on Other Individuals or Species for Habitat**

Adult: The primary pollinator, Macrotera parkeri, is a widespread, but rare bee species and is on the Texas list of species of greatest conservation need (USFWS, 2020).

**Habitat Narrative**

Adult: Inhabits grey limestone hills within a semidesert grassland, with small shrubs, other succulents, and grama grasses (NatureServe, 2015). Found only on one type of high-calcium limestone outcrop in the Mexican Highland vegetation community at elevations of 1,280-1,433 meters (4,200 feet). Soils are thin with a soil crust of lichens, mosses, and algae, and bedrock is very near the surface at occupied sites. Plants tend to be in the open, not underneath other plants. Overall vegetation at occupied sites is sparse (USFWS, 2016). The soils are low in nutrients, with a pH of 7.9 to 8.0. Plants require well-drained substrates and grow in full sunlight. Within their limited habitat (10-16 sq. km), the plants are found scattered, with a few dense clumps ranging from 100-1,000 individuals (Zimmerman 1985) (USFWS, 2007).

***Dispersal/Migration***

**Dispersal**

Adult: Moderate (inferred from USFWS, 1993)

**Dispersal/Migration Narrative**

Adult: Zimmerman (1985) speculates that seeds are disseminated by rock wrens (Salpinctes obsoletus), cactus wrens (Campylorhynchus brunneicapillus), mockingbirds (Mimus polyglottos), black-throated sparrows (Amphispiza bilineata), thrashers (Toxostoma sp.), and house finches (Carpodacus mexicanus). The bright red, fleshy fruits probably attract the birds. He notes that his unpublished study of rock wrens in a population of Coryphantha robbinsorum showed that these birds fly from one Coryphantha population to another during their daily activities (USFWS, 1993).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Declining (USFWS, 2007); Between 1989 and 2006, Cochise pincushion cactus individuals in 3 circular plots were monitored 14 times and all 3 plots had an overall declining trend (USFWS, 2020). The work since 2009 paints a different picture than the plots of 1989-2006. The population is thought to be stable (USFWS, 2020).

**Population Growth Rate:**

There appears to be a good distribution of Cochise pincushion cactus size classes, including some smaller and larger individuals, though most were intermediate sized individuals (USFWS, 2020).

**Number of Populations:**

2 (NatureServe, 2015)

**Population Narrative:**

It occupies 8.8 acres of rangeland (in U.S.?). This species is known only from 1 population in southeastern Arizona and 1 in adjacent Sonora, Mexico (NatureServe, 2015). The known range is very small and limited (USFWS, 2016). Population numbers appear to be declining based on current data (USFWS, 2007). The Cochise pincushion cactus is known from among several Permian limestone hills in southeastern Cochise County, Arizona. Once thought to have occurred in northern Sonora, Mexico, the species has never been found in that country (USFWS, 2020).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats include grazing by livestock and wildlife, and oil/mineral exploration activities. Changes in grazing patterns by the local landowner have minimized the potential effects from livestock grazing. Impacts to populations from mining activities have not been a significant factor. However, each of these activities continues to be a potential threat to populations of Cochise pincushion cacti. Impacts from these threats could increase if land ownership changes or incentives for oil and mineral exploration increase. A new threat that has been escalating over

the past 10 years is related to illegal immigration and drug smuggling, and associated law enforcement activities. Plants can be trampled or otherwise damaged or injured. Cochise pincushion cactus habitat is destroyed or altered by foot and vehicle traffic, and there is the potential for the increased incidence of fire. Impacts from border activities have been documented within areas occupied by the Cochise pincushion cactus, but increased law enforcement efforts have, at least temporarily, reduced illegal traffic in the area (USFWS, 2007). In 2006, Cochise pincushion cactus plots were reported vandalized with many nails and tags removed; trash and other evidence of human visitation was also present (USFWS, 2020). Cochise pincushion cactus habitat continues to be used by cross-border violators, as evidenced by trails and litter in some areas (USFWS, 2020).

**Stressor:** Invasive plants (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An additional threat comes in the form of invasive plant species, especially grasses. Of particular note is the spreading threat to Sonoran and Chihuahuan desert ecosystems resulting from the invasion of buffelgrass (Pennisetum ciliare). Buffelgrass can compete for resources with Cochise pincushion cactus, and it also increases the frequency and intensity of fire on the landscape as compared to natural conditions. Such a change in the fire regime could increase Cochise pincushion cactus mortality and alter important habitat microclimates. The recent development of a cold-tolerant strain of buffelgrass by the Agricultural Research Service (2005) increases the potential for this species to invade areas occupied by the Cochise pincushion cactus. Lehmann's lovegrass (Eragrostis lehmanniana) is another invasive grass species in southeastern Arizona (USFWS, 2007).

**Stressor:** Collection (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The desirability of this species, coupled with its limited distribution, increases the potential for significant impacts to populations if illegal collection were to occur. No evidence of illegal collection within known populations has been observed. However, collection remains a real threat to this species due to its limited numbers and distribution. Cochise pincushion cacti are available commercially on a limited basis, but if interest in this species increases or commercial availability decreases, pressure to collect plants from the wild may increase. The unique, rare nature of this species increases its desirability among collectors (USFWS, 2007). In 2019, a Cochise County Sheriff's Deputy provided a tip to U.S. Fish and Wildlife Service refuge law enforcement that a German national would be in the area to see and photograph Cochise pincushion cactus. Further investigation ultimately led to the man's arrest at the Denver Airport as he was attempting to smuggle Cochise pincushion cactus seeds out of the country. The man was found with 111 bags of cactus seed, including a purposefully mislabeled collection of Cochise pincushion cactus. The suspect admitted to collecting the seed from public lands and was arrested, released on $5,000 bond, and returned to Germany (USFWS, 2020).

**Stressor:** Insect depredation (USFWS, 2007)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Depredation by insects was documented in the Cochise pincushion cactus long-term monitoring plots in 1994. As a result, mortality of individual plants during that year nearly doubled from the highest mortality previously recorded (see Figure 2). The documentation of this significant depredation event points to the potential for the distribution of this species to be driven by density-dependent insect depredation. As the density of Cochise pincushion cacti increases in a local population, it becomes more vulnerable to insect depredation. At some point, densities may become high enough that conditions favor a significant insect depredation event. Density of cacti is reduced, as is the subsequent depredation by insects. This cycle may repeat itself over time within each of the local populations of Cochise pincushion cactus. As a result, there may be a number of high-density populations within the landscape; however, the density of these populations would eventually be reduced by insect depredation. Low-density populations will gradually increase in density during favorable environmental conditions until they reach a point that favors insect depredation events. In order to determine if this cycle of depredation is indeed a natural component of the population dynamics of the Cochise pincushion cactus, monitoring techniques must be modified to sample the population across its range. Depredation may be a significant driver of the distribution and density of this species. Depredation effects would be amplified in populations suffering from others stressors such as drought (USFWS, 2007).

**Stressor:** Drought (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Ongoing, long-term drought is occurring within the range of the Cochise pincushion cactus. Drought increases mortality of adults and juveniles and reduces reproduction in populations of this species. Because of the limited number of individual plants and the limited distribution of this species, drought effects may significantly affect its ability to persist on the landscape. A return to normal winter and monsoon precipitation patterns is needed to decrease this threat. The declining trend in numbers of cacti within monitoring plots is likely evidence of the effects of drought on known populations (USFWS, 2007). Not only does climate affect plants directly, it has been shown that climate coupled with other stressors, can have a cumulative impact resulting in greater than anticipated decline in rare species (USFWS, 2020).

**Stressor:** Pesticides (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Application of pesticides within or adjacent to the range of the Cochise pincushion cactus could adversely affect these insects and associated ecosystem functions. The potential application of pesticides is most likely associated with rangeland grasshopper control. The application of pesticides remains a potential threat to insects that benefit the Cochise pincushion cactus (USFWS, 2007).

**Stressor:** Small mammal herbivory (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Researchers noted that between 2016 and 2019, small mammal herbivory was much increased and associated flowering forbs were much decreased ; this is believed to be associated with ongoing drought in the region (USFWS, 2020). Recently documented extensive herbivory by small mammals has led to the removal of many adult plants, for example in 2019, 25 of 31 individuals monitored over time were removed by recent herbivory (USFWS, 2020). Despite this, small plants have appeared around the perimeter of missing plants (USFWS, 2020).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 8

**Delisting Criteria:**
Recovery of this species will require permanent protection and management of the habitat, trade protection through retention of the species on the Highly Safeguarded List of the Arizona Native Plant Law and CITES list following delisting, and demonstration through ten years of monitoring that viable populations are being maintained (USFWS, 1993).

**Recovery Actions:**

- Conduct biological studies necessary for effective management of the species (USFWS, 1993).
- Develop and implement a habitat management plan in cooperation with the private landowner and Arizona State Land Department (USFWS, 1993).
- Study the population biology of Cochise pincushion cactus to determine the effects of management (USFWS, 1993).
- Protect Cochise pincushion cactus from loss of individuals and habitat (USFWS, 1993).
- Establish an ex situ conservation and research program (USFWS, 1993).
- Define the range and distribution of Cochise pincushion cactus (USFWS, 1993).
- Modify the current monitoring protocol to expand the area monitored within the known range of the species. Design the protocol to more effectively evaluate the status of the species across the landscape. Monitoring should be designed to investigate possible density-dependent depredation issues and identify the distribution of both high-density and low-density populations (USFWS, 2007).
- Update the recovery plan with quantifiable criteria for delisting. For example, a goal of establishing 15,000 plants in 50 populations (Recovery Criteria #2) may not be realistic based on current information of the density and distribution of this species (USFWS, 2007).
- In conjunction with #2, evaluate the existing recovery actions outlined in the existing recovery plan and decide which are still appropriate for the species' recovery, based on current information (USFWS, 2007).
- Evaluate the results of Dr. Tom Van Devender's 2007 work on this species in Mexico and increase monitoring efforts in Mexico, if appropriate (USFWS, 2007).
- Continue to coordinate with and involve the landowners/lessees and SBNWR in recovery actions related to the Cochise pincushion cactus (USFWS, 2007).
- Evaluate the genetics of this species to determine variation within and among populations. This information is useful in determining if population augmentation or establishment of

new populations is warranted (USFWS, 2007).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The following are recommendations for future actions to conserve Cochise pincushion cactus and its habitat: 1) Work toward the purchase of some portion of Cochise pincushion cactus populations by a Federal entity (such as the expansion of the Buenos Aires National Wildlife Refuge). This would enable land management to benefit the species, and enable easy access to populations for monitoring, scientific study, and augmentation efforts. 2) Work toward building relationships with current landowners that would enable ease of access by researchers and land managers to survey, monitor, manage, and protect Cochise pincushion cactus. 3) Survey for additional Cochise pincushion cactus populations in appropriate limestone habitats in Arizona, New Mexico, and Mexico. 4) Continue annual monitoring of all accessible Cochise pincushion cactus populations, including attempting to relocate historical plots for re-measurement. 5) Work toward an understanding of stressor, threats, and conservation measures needed to help protect Cochise pincushion cactus. 6) Continue work at botanical gardens both developing plants for potential outplanting and periodically collecting seeds from a genetically diverse group of individuals for longterm storage. 7) Work toward public and partner education of the rarity and importance of Cochise pincushion cactus and the need for teamwork to conserve the species. (USFWS, 2020)
- Continue work at botanical gardens both developing plants for potential outplanting and periodically collecting seeds from a genetically diverse group of individuals for long-term storage
- Work toward the purchase of some portion of Cochise pincushion cactus populations by a Federal entity (such as the expansion of the Buenos Aires National Wildlife Refuge). This would enable land management to benefit the species, and enable easy access to populations for monitoring, scientific study, and augmentation efforts.
- Survey for additional Cochise pincushion cactus populations in appropriate limestone habitats in Arizona, New Mexico, and Mexico.
- Continue annual monitoring of all accessible Cochise pincushion cactus populations, including attempting to relocate historical plots for re-measurement.
- Work toward public and partner education of the rarity and importance of Cochise pincushion cactus and the need for teamwork to conserve the species.

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Recovery of this species will require permanent protection and management of the habitat, trade protection through retention of the species on the Highly Safeguarded List of the Arizona Native Plant Law and CITES list following delisting, and demonstration through ten years of monitoring that viable populations are being maintained (USFWS, 1993). USFWS. 2020. Cochise pincushion cactus (Coryphantha robbinsorum) 5-Year Review: Summary and Evaluation. 21 pp.

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# SPECIES ACCOUNT: *Coryphantha scheeri var. robustispina* (Pima pineapple cactus)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** PPC

**Listing Status:** Endangered; 10/25/1993; Southwest Region (R2)

**Physical Description**

Individuals of C. scheeri var. robustispina are small, hemispheric to cylindrical, stem succulent perennials of the Cactaceae (cactus family). Individual stems reach 5 to 46 centimeters (cm) (1.9 to 18.1 inches (in)) in height and 5 to 21 cm (1.9 to 8.3 in) in diameter, are comprised primarily of tough, fleshy pulp, and are protected by a leathery outer skin. Stems may be singular or form clumps. The surface of the stems is covered in 2 to 3 cm (0.8 to 1.2 in) long rounded projections called tubercles, each of which is grooved along the upper surface and contains one to several extra- floral nectaries (place that secretes nectar to attract pollinators) along the groove.. At the tip of each tubercle, arising from small bumps called areoles, are groupings of 7 to 20 straw-colored spines that darken with age (Roller 1996a, p. 9; Parfitt and Gibson 2004, p. 226). There is an average of two thick central spines, one of which is generally hooked and averages 1.7 millimeters (mm) (0.07 in) thick and 3 cm (1.2 in) long (Baker and Butterworth 2013, p. 996). There are 6 to 16 thinner radial spines about 1.1 to 3.5 cm (1.43 to 1.38 in). The young areoles are densely covered with deciduous wool. The stems of C. scheeri ssp. robustispina arise from taproots that are deeper than most Sonoran Desert cacti at about 15 cm deep. Lateral roots are found between 2 and 5 cm below the soil surface and extend approximately 1 m (3.28 ft) in length. The flowers of C. scheeri ssp. robustispina average 6.5 cm (2.6 in) long with pale yellow tepals (petals and sepals) that are variously tinged with red pigments. Flowers generally open early to mid-July following summer rains; fruit matures a few weeks later. The pale green fruits are narrowly ellipsoid, 3.2 to 5.7 cm (1.25 to 2.25 in) long and 1.3 to 1.9 cm (0.5 to 0.75 in) wide, with a soft rind and juicy sweet pulp surrounding a mass of brown to black seeds. (USFWS, 2018a)

**Taxonomy**

Arthur Schott originally described the taxon as Mammillaria robustispina from a collection he made from near El Sásabe, Sonora, Mexico (holotype MO 2017438) and the name was published by George Engelmann in 1856 (M. robustispina Schott ex Engelmann). Britton and Rose (1923, pp. 33-34) transferred the species to Coryphantha (C. robustispina). The name of the taxon was recombined by Benson (1982, p. 820) to C. scheeri var. robustispina and then again to C. robustispina (Schott ex Engelm.) Britton & Rose ssp. robustispina by Taylor (1998, pp. 17-18). According to Taylor, the species name C. robustispina has priority over the epithet C. scheeri. This view is accepted by Anderson (2001, p. 196). Within the 2018 Recovery Plan, however, we refer to the taxon as C. scheeri var. robustispina, the name in use when the taxon was listed as endangered under the Act in 1993 and how the taxon has been referred to in Service documents since that time. A morphometric study in 2004 suggested that a taxonomic cline exists between all C. robustispina occurring between Arizona and Texas and therefore no varieties are valid (Schmalzel et al. 2004, p. 553). Three varieties; robustispina, uncinata and scheeri, have been investigated recently and were shown to be geographically isolated (Baker 2005, p. 6), significantly different morphologically (Baker 2003, p. 17), and significantly different genetically (Butterworth 2010, p. 14; Baker and Butterworth 2013, p. 996), warranting subspecific division. We accept this varietal differentiation in this document. (USFWS, 2018a)

**Historical Range**

See Current Range. There is no indication that the historical range of the taxon differs widely from the current known distribution. (USFWS, 2018a)

**Current Range**

Found across roughly 152,920 ha (377,873 ac) of land within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including some lands that connect the two valleys. (USFES, 2018a)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Obligate outcrosser

**Lifespan**

Adult: Variable, can be 30 or more years (USFWS, 2018a)

**Dependency on Other Individuals or Species**

Adult: Pollinators

**Breeding Season**

Adult: Early to mid-July or five to seven days after the first summer rains of at least 3 mm and continues through the monsoon season. (USFWS, 2018a)

**Other Reproductive Information**

Adult: Flower buds begin to appear in mid-May and the timing is related to photoperiod and rainfall (Roller 1996a, p. 58). Flowering usually occurs in early to mid-July or five to seven days after the first summer rains of at least 3 mm and continues through the monsoon season (Kearney and Peebles 1951, p. 577; Roller 1996a, p. 58; Kidder 2014, entire). Flowers persist for a single day, yet the timing of flowering may assist with pollination, as there are few cactus species which bloom at this same time, resulting in a greater potential for pollination success (McDonald and McPherson 2005, p. 531). Schmalzel (2014, p. 4) suggests that plants do not reach maturity and begin to flower until they are more than 12 years of age and likely between 20 and 25 years of age. (USFWS, 2018a)

**Reproduction Narrative**

Adult: Pollinators of C. scheeri var. robustispina are fairly well known. Flowers of the taxon are morphology typical for the subgenus Cactoideae and exhibit characteristics considered generalized with respect to pollination, that is, the pollen being easily accessible to many different types of pollinators. Known pollinators include both native insects and the nonnative European honeybees (Apis mellifera) (Roller 1996a, p. 63). Coryphantha scheeri var. robustispina become isolated from potential pollination after 600 m (1,968.5 ft) and since the taxon is not able to self-pollinate (Service 2000a, p. 4), they are likely to be genetically isolated or inbred after 900 m (2,953 ft; McDonald 2005, p. 30). Pups (offsets of the parent cactus that are genetically identical) produced vegetatively will not increase genetic diversity of the population. (USFWS, 2018a)

**Habitat Type**

Adult: Semi-desert grasslands, desert scrub and the transition area between the two vegetation types.

**Dependencies on Specific Environmental Elements**

Adult: Open and transitional areas; deep, silty and gravely, alluvial soils (USFWS, 2018a)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2018a)

**Tolerance Ranges/Thresholds**

Adult: Found at elevations between 728 and 1,280 m (2,388 and 4,200 ft) (USFWS, 2018a)

**Habitat Narrative**

Adult: Coryphantha scheeri var. robustispina is typically found in open areas within the Sonoran Desert-scrub and desert-grassland vegetation types and in areas transitional between these vegetation communities. Routson (2003, p. 3) found that individuals of C. scheeri var. robustispina within the Altar Valley occurred most frequently in disclimax (displaced climax due to disturbance) desert-grassland among woody vegetation on well-drained soils. Many studies describe the subshrubs Zinnia species (desert zinnia), Gutierrezia sarothrae (snakeweed), Isocoma tenuisectus (burroweed), and Eriogonum spp. (buckwheat) as common associates. Schmalzel (2000c, p. 2) noted greater rates of mortality among C. scheeri var. robustispina occurring under the canopies of Prosopis velutina (velvet mesquite). Similarly, Kidder (2014, entire) found occupied sites were characterized by overall high incoming solar radiation (Kidder 2015, p. 110). McPherson (2002, p. 3), however, found individuals occur more frequently under the canopy of perennial plants than at a distance of at least 1 m (3.28 ft) from the canopy edge. (USFWS, 2018a). Coryphantha scheeri var. robustispina is a taxon of lower Sonoran desert-scrubland, desert-grassland, and the ecotone (transition area) between desert-scrubland and desert-grassland in southeastern Arizona and adjacent Sonora, Mexico. The primary habitats of Coryphantha scheeri var. robustispina are open areas on flat ridge tops or areas with less than 10 percent slope, which are also areas very well suited for human development (USFWS, 2024)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low

**Dispersal**

Adult: Rabbits and rodents act as seed disperses.

**Dependency on Other Individuals or Species for Dispersal**

Adult: Rabbits and rodents for seed dispersal (USFWS, 2018a)

**Dispersal/Migration Narrative**

Adult: Fruit and seed dispersal for the taxon is probably facilitated, for the most part, by rodents and, perhaps less so, by ants. It has also been hypothesized that jack rabbits (Lepus spp.) may play a key role in fruit and seed dispersal (Westland 2005, p. 33; Schmalzel and McGibbon 2010, p. 11). In 2001, Westland (2005, p. 33) examined jackrabbit dung and discovered intact C. scheeri var. robustispina seeds within. They noted that dung increased around plants at the time fruits are maturing. A study conducted by Baker and Routson beginning in 2002 documented that ants were mostly associated with extrafloral nectaries, however there were multiple cases of ants eating the fruits and transporting seeds (Baker 2013, p. 21). This study also documented the presence of a single seed in jackrabbit feces, which supports the jackrabbit dispersal hypothesis (Baker 2013, p. 33). In a study of antelope jackrabbit (Lepus alleni ) habitat structure and vegetation characteristics, Altemus (2016, p. 10) did not detect a spatial association between the jackrabbits and the presence of C. scheeri var. robustispina, but suggested further study was warranted, as this was a habitat selection study for the herbivore and did not emphasize the distribution of fruits. Additionally, Harris' antelope squirrels (Ammospermophilus harrisii), (USFWS, 2018a)

**Additional Life History Information**

Adult: Ample seed production, however, does not necessarily equate to persistant seedbanks or recruitment (e.g. see Godinez-Alvarez et al. 2003, p. 183; Aragon and Lasso 2018, p. 1). One field study reported the results of two trials where 200 or more C. scheeri var. robustispina seeds were planted in close proximity to in situ C. scheeri var. robustispina adult plants and germination was followed (Schmalzel 2002, p. 7). In the first trial, 16 of 220 seeds germinated in the first year and none in the second. In the second trial, 35 of 200 seeds germinated; 30 in the first year and 5 in the second year of study (Schmalzel 2002, p. 7). In another study, field germination testing from 5 study sites found that C. scheeri var. robustispina seeds had high germination rates of 88 percent (Roller 1996a, p. 75). Observations from laboratory and shadehouse over a 22-month period showed continuous germination indicating that there is no set dormancy period for the seeds (Roller 1996a, p. 72). (USFWS, 2018a)

***Population Information and Trends***

**Population Size:**

Roughly 8000 individuals and 152,920 ha (377,873 ac) of habitat (USFWS, 2018b)

**Additional Population-level Information:**

Between 1995 and 2007, 45 individual C. scheeri var. robustispina were monitored in an exclosure on Coronado National Forest land in the Santa Cruz Valley. In 2010, no living plants were found (Coronado National Forest 2010, entire), however, in a partial survey of this area in 2015, some C. scheeri var. robustispina were found both within and outside of this exclosure (Service 2015b, entire). Similarly, plants are monitored regularly on the Pima County and Palo Alto Pima Pineapple Cactus Conservation Bank properties. On one portion of the County-owned Conservation Bank property in 2006, 67 plants were mapped; when last counted in 2014, 13 of the original 67 plants remained alive and 11 new plants had been found (Pima County 2015, p. 1). Within or adjacent to the Palo Alto Conservation Bank property, 49 plants were found in

2001; as of September, 2015, 9 of the original individuals remained alive and 11 new plants were discovered, for a total of 24 known C. scheeri var. robustispina (Westland 2015, p. 2). (USFWS, 2018a)

**Population Narrative:**

We are aware of roughly 8,000 individuals and 152,920 ha (377,873 ac) of habitat within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including acreage of some lands that connect the two valleys. Maintaining linkages for pollinators and lands dominated by native plants are important for the survival of the taxon. Long-term monitoring plots of Coryphantha scheeri var. robustispina indicate overall decreases in the number of individuals monitored over time. Attempts at transplanting individuals out of the path of development has resulted in a mix of successes and failures. We are aware of at least 1,837 individuals and tens of thousands of acres of habitat that have been lost, primarily due to development. (USFWS, 2018b)

***Threats and Stressors***

**Stressor:** Habitat loss due to commercial development (2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary habitats of C. scheeri var. robustispina are open areas on flat ridge tops or areas with less than 10 percent slope, which are also areas very well suited for human development. Urban and suburban development in the areas south and west of Tucson, Green Valley, and Nogales, Arizona, and mining in the Sierrita Mountains and Green Valley, threats first recognized in the 1980s (Phillips et al. 1981, p. 11; Mills 1991, p. 7; Reichenbacher 1985, p. 21; Service 2000a, p. 7), are responsible for complete and permanent modification of lands that previously supported C. scheeri var. robustispina and its pollinators. By 2000, the Service estimated that 43 percent of the total habitat surveyed to date had been modified or destroyed due to urbanization (Service 2001a, p. 6). For example, 143 ha (353 ac) of habitat and 47 individual plants were lost to a single housing development project in 1998 (Service 1998c, p. 16). In 2014, 197 ha (487 ac) of suitable C. scheeri var. robustispina habitat and 99 individual plants were lost to a single infrastructure development project (Service 2014a, p. 33). (USFWS, 2018a)

**Stressor:** Habitat loss due to nonnative plant invasion and altered fire regimes (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Coryphantha scheeri var. robustispina occur in both the desert-grassland and desert-scrubland plant communities, especially in the ecotone of the two (Roller 1996a, p. 9). Invasive nonnative grasses in both communities compete with native plants for water and nutrients, reduce community composition and structure, and alter fire frequency and intensity. Historically, low severity fires that occured every 10 to 20 years in grasslands, or every 250 years in deserts, likely posed no threat to the long-term survival of C. scheeri var. robustispina individuals. When invaded by invasive nonnative grasses, fire frequency and intensity increase, leading to the deterioration of both natural grassland and desert communities. Invasive nonnative grasses produce more fine fuels than native vegetation, allowing for a more uniform and higher intensity burn compared with the discontinuous fuels of some native grasslands and deserts, thus

reducing the number of microsite refuges safe from fire. Coryphantha scheeri var. robustispina is not fire adapted, but may survive fires through refugia (e.g. older soils or spaces between native plants), chance, shrinking into the ground, reproducing through basal resprouting, or possibly recolonization from a surviving seedbank, barring adequate rainfall to allow for survival. Further research into the relationship of fire, drought, nonnative species, soil types, and C. scheeri var. robustispina and their seedbanks would help to better understand the tolerance of this taxon to wildland and prescription fires. Research into desert-scrubland and desert-grassland restoration (e.g. removal of nonnative grasses and the establishment of native plants) is also essential, as this is a large-scale problem currently without large-scale solutions. (USFWS, 2018a)

**Stressor:** Effects of Livestock Grazing (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some livestock grazing practices that occurred in the past have resulted in enduring landscape-level impacts, because recovery in dryland ecosystems is slow or stagnant. Historically overgrazed lands have altered microclimate and hydrology, increased soil compaction and erosion, reduced structural complexity and abundance of the vegetation community, and species composition; all of which may impact the current suitability of habitat for C. scheeri var. robustispina in certain areas of its range. In general, poorly managed livestock grazing may negatively impact C. scheeri var. robustispina seedlings and adult plants through soil erosion, soil compaction, hydrologic and micro-climatic changes, and invasion or expansion of invasive nonnative grasses. Low to moderate intensity grazing however, may also aid C. scheeri var. robustispina through the creation of open areas temporarily free of competition and with reduced fuels (Service 2000a, p. 9). Additional research into the relationships between livestock use and C. scheeri var. robustispina is needed to determine both the benefits of grazing and the threshold at which disturbance no longer benefits the taxon. In addition, research is needed into restoration of native species and fire regimes on desert grasslands and desertscrub. (USFWS, 2018a)

**Stressor:** Recreation and Border Activity (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-road vehicle use and illegal border activity contribute to the overall degradation of C. scheeri var. robustispina habitat. In addition, individual C. scheeri var. robustispina have been run over by off-road vehicles. Although these activities could impact individual C. scheeri var. robustispina, off-road vehicles and illegal border activity are not likely significant sources of mortality for the taxon as a whole. (USFWS, 2018a)

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Illegal collection of C. scheeri var. robustispina is difficult to detect and only one incident has been reported in recent years. Although illegal collection could impact C. scheeri var. robustispina, it is not as significant a threat for the taxon as previously thought. The

determination to not designate critical habitat for the species has helped reduce this threat by not making maps publically available, and continued outreach and education related to the issue of illegal collection remain important tools in the conservation of this taxon. (USFWS, 2018a)

**Stressor:** Disease or Predation (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In general, cacti are susceptible to attacks from numerous types of insects, and C. scheeri var. robustispina is no exception. The interior flesh of cacti provides both a nesting area and food source for beetles, weevils, and other insects. Once an infestation has occurred, cacti can die from the feeding and tunneling activities of insects or from the introduction of fungus or disease. Plants already stressed from prolonged drought are more susceptible to insect attack and disease, as drought may cause physiological stress responses in plants, such as limiting their photosynthesis and cell. Predation by mammals and insects occurs on both adult C. scheeri var. robustispina and seedlings. Primary insect predators of C. scheeri var. robustispina are the native Gerstaeckeria sp. (cactus weevil), the native Moneilema sp. (cactus beetle), and the native Cactobrosis sp. (pyralid moth). Ants have been documented on C. scheeri var. robustispina and will consume seed, however they are not specialists of C. scheeri var. robustispina. O'Dowd and Hay (1980, p. 539) suggest that ants may also aid in reducing the seedbank of competing plant species. Predation of Coryphantha scheeri var. robustispina by mammals is well-documented. Harris' antelope squirrel), antelope jackrabbits and desert cottontails are known to eat stem material of C. scheeri var. robustispina, especially when other food sources are scarce, such as in times of drought. Researchers have documented C. scheeri var. robustispina mortality caused by javelina (Pecari tajacu). These and other animals can also impact cacti by digging under stems, or, at least for larger animals, knocking over or trampling stems. In summary, there are many insect and mammalian predators to C. scheeri var. robustispina adults and seedlings. Predation increases during times of drought and following damage to a cacti's protective spines, such as post-fire. Many individual C. scheeri var. robustispina die or become disposed to death annually from predation which has been recorded on numerous occasions over the past decade. (USFWS, 2018a)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because most C. scheeri var. robustispina occur on private and State Trust lands, they and their habitats are not subject to Federal protection unless there is a Federal nexus to a proposed action. Habitat loss due to urbanization remains a substantial threat to C. scheeri var. robustispina on these lands. Although best management practices may be implemented with regard to development, nonnative plant invasion and associated alteration of fire regimes, recreation, border issues, and the presence of livestock, management is not continuous across the range of the species and C. scheeri var. robustispina remain vulnerable to these threats and stressors. There are no regulations in place that address stressors to C. scheeri var. robustispina and its habitat from predation, drought and climate change, or small population size. (USFWS, 2018a)

**Stressor:** Drought and Climate Change (USFWS, 2018a)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cacti are vulnerable to disturbance because they grow slowly, their germination and establishment occurs with low frequency, and they have little capability to recover from disturbance (Portilla 2011, p. 509). Disturbance can reduce recruitment, survival, fecundity, and population growth; disturbance coupled with drought, however, can exacerbate negative impacts on cacti. In summary, since the late 1990s, the southwestern United States has been experiencing drought conditions and increasing high temperatures. Climatic predictions suggest continued less frequent, but perhaps more intense, summer precipitation, reduced winter precipitation, and increasing temperatures in this region. Drought and increased temperatures increase C. scheeri var. robustispina stress, reduce defenses to predation and disease, and reduce reproduction, among other impacts. These impacts will continue to affect C. scheeri var. robustispina and its habitat throughout its range into the foreseeable future. (USFWS, 2018a)

**Stressor:** Small Population Size and Isolation (USFWS, 2018a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** High species diversity within the vegetative community is important to the survival of C. scheeri var. robustispina, as this cactus is not abundant enough to sustain its main pollinators. A key pollinator for C. scheeri var. robustispina is Diadasia rinconis, a cactus specialist bee which requires species of Cylindropuntia, Opuntia, and Ferocactus to survive. C. scheeri var. robustispina is a sparsely distributed plant that requires habitat connectivity and proximity to other plants for effective pollination. Large scale threats and stressors such as habitat degradation and regional drought increase the potential for isolation and genetic loss. Current information indicates that roughly 98 percent of all known C. scheeri var. robustispina occur within 900 m (2,952.8 ft) of one another. Should development or other threats or stressors remove or cause the deterioration of corridors and connectivity, this could result in genetic isolation and inbreeding. (USFWS, 2018a)

***Recovery***

**Reclassification Criteria:**
1. Threats and Habitat Criterion: At least 8,094 hectares (ha) (20,000 acres [ac]) of C. scheeri var. robustispina habitat per recovery unit are documented to be of optimal quality and remain that way through successful resource management, land conservation, and restoration techniques such as in situ germination. At least 24,281 ha (60,000 ac) of C. scheeri var. robustispina habitat per recovery unit are documented to be of good quality and remain that way in perpetuity. Habitat is considered optimal quality when it: is protected for conservation purposes; is managed in a manner that promotes the long-term survival of C. scheeri var. robustispina; has less than 20 percent cover of C. ciliaris, E. lehmanniana, or other invasive nonnative plant species that alter ecosystem function; contains contiguous habitat and corridors for pollinators; and the C. scheeri var. robustispina population is observed to be stable or increasing. Habitat is considered good quality when the cover of C. ciliaris, E. lehmanniana, or other nonnative plants that alter ecosystem function remains between 20 and 35 percent; the land is managed in such a way that promotes the continued existence or expansion of long-term survival of C. scheeri var. robustispina. Collectively, this represents approximately 42 percent of the known range of

C. scheeri var. robustispina. Additional acres of lesser quality C.scheeri var. robustispina also exist throughout the range of the species; some of whichoccurs on lands where ongoing efforts may continue to improve habitat quality. (USFWS, 2018a)

2. Conserve, protect, and restore mature C. scheeri var. robustispina individuals, theirseedbanks (approximately 10 meters), and habitat for pollinators (approximately 900 meterradius) in each recovery unit through resource management, land conservation, andrestoration techniques such as in situ germination. Quantitative monitoring, using a standardized monitoring protocol, of established plots across a variety of land ownerships and land management scenarios, with landowner support, is conducted within each of the two recovery units every 3 to 5 years. Plots demonstrate that the population is stable or increasing a minimum of 10 years over a 15-year period. (USFWS, 2018a)

Recovery Priority Number: 3

**Delisting Criteria:**
The first two criteria for downlisting must be met or surpassed, and monitoring must demonstrate that the population is increasing for a minimum of 20 years over a 30-year period. The additional time necessary to achieve delisting ensures continued population viability. Additionally, it will allow land managers to continue to reduce threats to C. scheeri var. robustispina from nonnative species invasion achieved during downlisting and track the long-term effectiveness of management. The additional time will also allow land managers to develop methods to reduce anticipated cost and effort needed to maintain habitat and population viability absent the protections of the Act. (USFWS, 2018a)

**Recovery Actions:**
- Conserve existing and newly discovered C. scheeri var. robustispina and associated habitat, including unoccupied areas that provide habitat and connectivity for pollinators. Promote urban planning for compact urban development, increase open space preservation and management (e.g. restrictions on trash dumping, off road vehicle use, placement of pedestrian trails, etc.), and connective habitat corridors. Engage in land acquisition to reduce habitat fragmentation and increase connectivity. Develop conservation easements for the protection of C. scheeri var. robustispina on private lands. Develop and monitor conservation mitigation banking to promote the protection of C. scheeri var. robustispina habitat. (USFWS, 2018a)
- Restore quality C. scheeri var. robustispina habitat in the U.S. and Mexico. Develop and implement land management plans that support and promote the taxon, including through the reduction of nonnative plant species and unnatural fire regimes, soil erosion, soil compaction, and headcutting. Work toward a better understanding of transplanting and seeding requirements for C. scheeri var. robustispina which could be implemented in appropriate habitat. (USFWS, 2018a)
- Develop range-wide standardized long-term monitoring of individuals in established plots, as well as their habitats, threats, and stressors. Monitor individuals in established plots across the range of the taxon using a tested standard protocol to enable an understanding of the long-term trend of the species, its habitat, threats, and stressors. Check the effectiveness of management actions by monitoring individuals subjected to natural and prescribed fire, mechanical site disturbance, various grazing regimes, various restoration techniques, and other management considerations. Monitor in situ grown and transplanted

individuals for effectiveness of sowing, planting, and transplanting protocols. (USFWS, 2018a)

- Encourage scientific study to improve our understanding of C. scheeri var. robustispina biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitats, distribution, and genetics in the United States and Mexico. Identify information gaps, compatible land uses, threats, stressors, and appropriate management actions that lead to the conservation of the taxon. Conduct surveys in appropriate habitat, using a tested standard protocol, to better understand the geographic range and habitat requirements of the taxon. Investigate the feasibility of alternative survey methodologies, such as the use of detection dogs, drones, and distance sampling. Conduct research related to the biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitat, and genetics of the taxon. (USFWS, 2018a)
- Maintain plants in captivity at botanic gardens and seeds at seed storage facilities; encourage research into propagation, in situ seed planting, and transplanting methods. Promote the propagation and planting of individuals ex situ at botanic gardens for conservation and public education purposes. Maintain seed from plants across the geographic range of the taxon for conservation purposes. Develop effective approaches to in situ conservation. (USFWS, 2018a)
- Develop public outreach, collaborative partnerships, and agreements with private landowners in the United States and Mexico that encourage C. scheeri var. robustispina conservation. Increase public outreach regarding threats, stressors, and conservation measures relating to C. scheeri var. robustispina in both the United States and Mexico. Develop collaborative partnerships and agreements with private landowners that result in management plans or that otherwise encourage C. scheeri var. robustispina conservation in the United States and Mexico. Develop a recovery implementation team comprised of species experts, agency and non-government agency partners, landowners, and stakeholders to meet regularly, review progress, discuss problems, and revise this plan as needed. (USFWS, 2018a)

***Conservation Measures and Best Management Practices:***

- The principle recovery strategy is to conserve the habitat of Coryphantha scheeri var. robustispina by protecting habitat, restoring habitat, and protecting Coryphantha scheeri var. robustispina individuals, their seedbanks, and habitat for their pollinators. Providing conservation and restoration of the taxon and its habitat will allow a stable, self-sustaining population to persist with some level of connectivity and opportunities for expansion and dispersal. Additional actions needed include monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors. Several recovery actions listed in the Recovery Plan are already under way, including protection of land from development (USFWS, 2018)..
- RECOMMENDATIONS FOR FUTURE ACTIONS The principal recovery strategy is to conserve the habitat of Coryphantha scheeri var. robustispina by protecting habitat, restoring habitat, and protecting Coryphantha scheeri var. robustispina individuals, their seedbanks, and habitat for their pollinators. Providing conservation and restoration of the taxon and its habitat will allow a stable, self-sustaining population to persist with some level of connectivity and opportunities for expansion and dispersal. Additional actions needed include monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors. Several recovery actions listed in the Recovery Plan (U.S. Fish and Wildlife Service 2018)

are already under way, including protection of land from development. If in the future the Recovery Plan becomes necessary to revise, the U.S. Fish and Wildlife Service will follow the protocol for a Recovery Implementation Strategy and include interested parties and cooperatives (USFWS, 2024).

**References**

USFWS. 2018a. Recovery plan for Pima pineapple cactus (Coryphantha scheeri var. robustispina). U.S. Fish and Wildlife Service, Southwest Region, Tucson, Arizona. 76 pp + 2 Appendices.

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# SPECIES ACCOUNT: *Coryphantha sneedii var. leei* (Lee pincushion cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/26/1979; Southwest Region (R2)

**Physical Description**

Both the Sneed and Lee pincushion cacti are many branched, forming tight clumps of up to 100 or more stems. Individual stems are cylindroid or spherical to club-shaped, 2.5-7.5 cm long (1.0-2.9 inches) and 1-3 cm in diameter (0.4- 1.2 inches) with tubercles up to 3mm long (0.12 inches). The tubercles are persistent and hard after fall of the spines. The spines hide the stem. The central spines are acicular, white, tipped with pink and brown, 3-14 cm long (1.2-5.5 inches) and about 6-17 per areole. The radial spines are white, 3-12 mm long (0.2-0.47 inches) and 35-90 per areole. The flowers are about 1.2 cm tall (0.5 inches) and of equal diameter, not opening widely; they are brownish-pink to pale rose with pink filaments and bright orange anthers. The fruits are greyish-green, or greenish tinged with brown, or rarely pinkish when ripe. They are clavate up to 1.5 cm long (0.6 inches) and 6 mm in diameter (0.24 inches). The seeds are reddish-brown, 0.7-1 mm long (.027-.039 inches), and 1.25-1.5 mm broad (.049-.059 inches) (Benson, 1982). In the Lee pincushion cactus, the spines are deflexed on medium and small stems, slanting from the top of the tubercle toward the main portion of the stem; the flowers are dull medium brownish-pink; the seeds are 1 mm long (.039 inches) and 1.5 mm broad (.059 inches) (Benson, 1982).(USFWS, 1986)

**Taxonomy**

In the recent taxonomic publications (Kartesz 1999; Baker and Johnson 2000; Anderson 2001), both varieties of Coryphantha sneedii are placed in the genus Escobaria Britton and Rose. Baker and Johnson (2000) note that this genus is sometimes considered a subgenus of Coryphantha. Anderson (200 1) uses the genus Escobaria in his book "The Cactus Family," stating that the International Cactaceae Systematics Group has accepted this genus. (USFWS, 2015)

**Historical Range**

Coryphantha sneedii var. leei is known only from the Guadalupe Mountains in New Mexico (Eddy County), within, and immediately adjacent to, Carlsbad Caverns National Park. At the time of listing, it was known to only occur in "several canyons" (Weniger 1969). (USFWS, 2015)

**Current Range**

Occurs in the Guadalupe Mountains (Eddy County) of New Mexico (NatureServe, 2015). This subspecies includes individuals from six canyons scattered in populations of low abundance over approximately 22 kilometers (14 miles) of the Guadalupe Mountains including BLM lands (Carlsbad District). (USFWS, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 1986; see dispersal narrative); sexual (inferred from USFWS, 1986)

**Breeding Season**

Adult: March - April (USFWS, 1986)

**Key Resources Needed for Breeding**

Adult: Winter and spring moisture, soils seed bank (USFWS, 1986)

**Reproduction Narrative**

Adult: Most Lee pincushion cacti bloom after 3 - 4 years. Plants bud in late March or early April; fruit formation is from August to November. Winter and spring moisture is important for bud set. Each fruit produces about 26 seeds and a flowering stem produces about 6 fruits. A typical plant may produce over 1,000 seeds per year. Since seeds can remain viable for up to 10 years, the soil probably contains a sizeable seed bank (USFWS, 1986).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Chaparral (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 1,220-1,800 m elevation (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: It is restricted to the Tansil Limestone Formation and grows only on north-facing limestone ledges, slopes and ridgetops, at 1,220-1,800 m elevation; precipitation averages 30 cm/year, in interior chaparral communities. The limestones are generally hard, resistant to erosion, and support a sparse vegetation of low shrubs, some rosette-forming perennials, many cacti, and both annual and perennial herbs (USFWS, 1986; NatureServe, 2015). Lee's occupies steep, rugged, remote terrain, so there has been limited survey effort relative to the extent of potential habitat for this species. Therefore, habitat and ecosystem conditions are largely unknown. Zimmerman (1985, p. 360) and Baker (2001e, 14119) observed that Lee's and Sneed's-form plants appeared to be stressed by the more arid conditions in lower elevation areas; plant appeared unhealthy, patches were confined to moister microhabitats, and/or recruitment of seedlings appeared to be limited. Therefore, habitat suitability and availability may be decreasing with increasing temperatures (USFWS, 2023)

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 1986)

**Dispersal/Migration Narrative**

Adult: Only about 10% of all stems are of the non-flowering type, and these are broken off by animals or shifting rocks and may root, establishing new plants. Most fruits are eaten by insects or rodents who probably scatter a few seeds in the process. Birds have also been observed to feed on the fruits and should at least occasionally serve as dispersal agents. If a fruit is not eaten, weathering breaks down the fruit wall causing the seeds to be dispersed by wind or rain (USFWS, 1986).

***Population Information and Trends***

**Population Trends:**

Not available

**Resiliency:**

Initial species abundance estimates were made in 1984–1985, so the current abundance of Lee's populations are unknown. Trend data last collected in 1992–1995 documented that monitored recreation effects plots were stable to increasing. This historic information is unlikely to be a reliable estimate of current abundance and/or trends given the extended droughts of 2002–2004, 2011–2014, and 2020–2022 (National Integrated Drought Information System n.d., unpaginated). Trend data last collected in 2018 from fire effects monitoring plots documented that both monitored burned and unburned fire effects plots were declining. However, these were targeted plots, which are known to be biased toward detecting declining trends that may not represent actual population-level trends. Trends for most occurrence areas have never been monitored. Habitat suitability and availability may be decreasing with increasing temperatures (Zimmerman 1985, p. 360; Baker 2001e, 14119). (USFWS, 2023)

**Representation:**

Lee's currently occupies 2–3, geographically isolated and genetically distinct representation areas, depending on phylogenetic analysis results: one core Lee's population (consisting of the Serpentine Bends/Dark Canyon/CrookedCreek, Walnut Canyon, Rattlesnake Canyon, North Slaughter Canyon/Middle Slaughter Canyon, Bear Canyon, Midnight Canyon, Putnam Canyon, West Slaughter Canyon, and Yucca Canyon occurrences) and one core Sneed's-form population (consisting of the Lefthook Canyon, Double Canyon, Cottonwood Canyon, Gunsight Canyon, and Big Canyon occurrences), as well as a third, isolated, Lee's individual (Sargent Canyon). Genetic diversity within and between occurrence areas and/or populations is unknown, but there's evidence of gene flow between West Slaughter Canyon and Yucca Canyon, between Big Canyon and Cottonwood Canyon, and between these sets of canyons. However, based on small population size(s), we suspect that Sneed's is experiencing a loss of evolutionary potential from loss of diversity through genetic drift, except, potentially, under Zimmerman's (1985, p. 359) rough range-wide abundance estimate, which includes Sneed's-form occurrences. Therefore, while evolutionary processes appear functional, Lee's may have a compromised capacity to adapt to changing environmental conditions. (USFWS, 2023)

**Redundancy:**

Lee's relatively continuous known range (excluding the Sargent Canyon occurrence) extends approximately 30 km (19 mi) southwest to northeast (including Sneed's-form individuals within putative Guadalupensis occurrences) or approximately 15 km (9 mi) southwest to northeast (excluding that core population). This range is not extensive enough to ensure geographic independence of the two core population areas that constitute this range given the potential extent of regional extended droughts (National Integrated Drought Information System n.d., unpaginated) and other destructive, broad-scale severe weather events, which can span several states. However, this range is extensive enough to ensure that wildfires and vegetation treatments wouldn't affect all occurrences simultaneously (Bureau of Land Management 2023, unpaginated), given that recent fires in comparable habitats (such as the Dog, Cottonwood, Potrillo, Brushy, Foster, and San Luis fires of 2021– 2023) ranged from 3–11 km (2–7 mi) in extent (National Interagency Fire Center 2023, unpaginated). (USFWS, 2023)

**Number of Populations:**
10-15 (USFWS, 2023)

**Population Size:**
1,000 - 2,000 (USFWS, 1986)

**Population Narrative:**
Presently, Coryphantha sneedii var. leei is known from very limited portions of six canyons in the Guadalupe Mountains (USFWS, 2015). There are an estimated 1,000 - 2,000 plants (Heil and Brack, 1985a) (USFWS, 1986). In 2015, we understood Lee's to include individuals from six canyons (Service 2015, p. 7). We now understand Lee's to occur within 10–15 canyons or canyon complexes, depending on the taxonomic identity of Sneed's-form plants within Guadalupensis occurrence areas (Table 1; see, also, section 2.2.1.5). Sneed'sform plants in the five southmost canyons (Big Canyon to Lefthook Canyon) aren't known to co-occur with plants exhibiting classic Lee's traits. Given our 2015 Lee's range extent estimate of 22 km (Service 2015, p. 7), we likely did not consider plants within these canyons in our last analysis of Lee's status. Except for the addition of Sargent Canyon, which was discovered in 2022, this increase in occurrence areas doesn't represent new detections or range expansion because the remaining occurrence areas have been documented since at least 2001.

***Threats and Stressors***

**Stressor:** Fire (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Presently, the threat of wild and prescribed fires in or around occupied Coryphantha sneedii var. leei habitat could prove problematic to its survival. Most of the park has burned since 1941 (NPS 2005, map, p. 6). While lightning ignitions probably took place frequently in the Guadalupe Mountains, most fires were likely quite localized and less intense prior to fire suppression (NPS 2005). Fire suppression in many ecosystems creates more uniform fuel loads that support more landscape-scale high intensity fires (NPS 2005). Specific impacts of wild and prescribed fire on Coryphantha sneedii var. leei are inconclusive (USFWS, 2015).

**Stressor:** Longhorn cactus beetle (USFWS, 2015)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** There has been one observation of adult Moneilema armatum (longhorn cactus beetle) on C. sneedii var. leei, eating portions of this cactus. It is unknown what impact, if any, longhorn beetles have on this species (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend. Munson et al. (20 14) predicts declines in vegetative cover including cacti in Chihuahuan Desert habitats due to climate change. Coryphantha spp. are likely to have experienced and rebounded from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species (USFWS, 2015).

***Recovery***

**Reclassification Criteria:**
Not applicable. (USFWS, 1986)

Recovery Priority Number: 3

**Delisting Criteria:**
TheLee pincushion cactus will be considered for delisting when:

1. All core populations demonstrate stable or increasing trends in abundance over a 20-year period. This will be based on periodic demographic trend monitoring and analysis implemented under the recovery actions. (USFWS, 2019)

2a. Maintain a minimum of three geographically separated core populations for each species over a 20-year period. (USFWS, 2019)

2b. A minimum of one new core population will be discovered (use Criterion 1) or established outside the current range and wholly separated geographically from the other core populations, and remain occupied for 10 years out of the 20-year survey period. (USFWS, 2019)

3a. Maintain genetic diversity within all core populations as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)

3b. Maintain presence in 80 percent of subpopulations over 20-year monitoring period and outside of the core populations, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)

4. Develop and implement a Habitat Management Plan (HMP) for Sneed and Lee pincushion cacti conservation. (USFWS, 2019)

5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

**Recovery Actions:**

- Remove threats of collecting by enforcement of existing regulations. Because of the rarity of the Lee pincushion cactus, the populations must be protected by enforcement of existing international, Federal, and State regulations. Determine the extent and impacts of collecting. Develop and implement a law enforcement strategy. Publicize successful law enforcement actions. (USFWS, 1986)
- Manage existing habitat for protection of the cactus. Habitat management for the Lee pincushion cactus should be done through existing agency management procedures and through cooperation with private landowners. The following should be accomplished. Agencies should remain informed of the location and status of Lee pincushion cactus populations. Develop and implement habitat management plans for all populations on public lands. Seek cooperation of landowners to protect and maintain populations on private lands. (USFWS, 1986)
- Gather information for use in management. In-depth knowledge of the plant's growth, distribution, population biology and ecology is needed to understand habitat requirements. The knowledge gained can be used to help sustain and manage healthy natural populations. Study population biology and ecology. Develop techniques to artificially propagate and transplant the Lee pincushion cactus. Inventory known populations and search for new populations in the Franklin and Guadalupe Mountains. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1986)
- Develop public awareness, appreciation and support for preservation of the Lee pincushion cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential to the ultimate success of the foregoing recovery measures. (USFWS, 1986)
- Recommendations for Future Actions from 2015 5-Year Review: • Determine if the genus associated with this species needs to be changed from Coryphantha to Escobaria on all future Service documents. • Revise the recovery plan for these species to incorporate new information on taxonomy, biology, ecology, and threats with management recommendations. Objective and measurable recovery criteria for down and de listing of the species should be developed which address all listing factors relevant to this species. • Develop a Coryphantha sneedii var leei and C. sneedii var. sneedii multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. • Develop standardized survey and monitoring protocols for these species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-

term trend analysis. Incorporate fire and climate change factors into long-term monitoring data collection. • Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). • Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. • Provide legally grown seeds and plants of Coryphantha sneedii var. leei and C. sneedii var. sneedii, as the known populations allow, to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti thr.oughout its range. • Provide viable Coryphantha sneedii var. leei and C. sneedii var. sneedii seeds to a seed bank operating under the Center for Plant Conservation guidelines. • Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of these species. • Determine microhabitat needs of these species ("nurse" plants, pollinators, precipitation needs- amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2015)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Resolve the taxonomic identity of Sneed's-form plants range-wide and in the Sneed'sform core population area. • Survey suitable habitats as predicted by probabilistic models for the presence/absence and extent of Lee's occurrences, starting with the Sargent Canyon occurrence area. Consider evaluating the feasibility of using aerially assisted remote sensing and artificial intelligence assisted object detection techniques to identify potentially occupied areas for on-the-ground presence/absence survey efforts. • Map the bounds of Lee's occurrences within occupied areas, using standardized and repeatable methods. • Install randomly or systematically located demographic and density monitoring plots throughout the species' range. Determine the plot specifications and sample sizes needed to achieve the desired statistical power experimentally. • Assess the probability of wildfire exposure in occurrence areas. • Assess microclimate refugia in and adjacent to occurrence areas. • Assess Lee's resiliency to, and capacity to adapt to, projected future climate changes. If resiliency and adaptive capacity are low, identify future suitable habitat areas using probabilistic models that incorporate the range of available future climate scenarios and time periods. • Collect seeds along >50 maternal lines per occurrence area for ex-situ, long-term conservation storage. Consider what germplasm may be needed for successful reintroductions when planning collections (Maschinski et al. 2012, entire). • Finalize protections for Lee's occupied and adjacent and intervening habitats, including future habitats, via special designations and associated mineral withdrawals and management prescriptions for the purpose of conserving Lee's. (USFWS, 2023)

**References**

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USFWS. 1986. Sneed and Lee Pincushion Cacti (Coryphantha sneedii var. sneedii and Coryphantha sneedii var. leei) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 53 pp. https://ecos.fws.gov/docs/recovery_plan/860321b.pdf USFWS. 2023. Lee Pincushion Cactus (Coryphantha sneedii var. leei) 5-Year Status Review: Summary and Evaluation. New Mexico Ecological Services Field Office. Albuquerque, New Mexico. 42 pp.

USFWS. 2015. Lee Pincushion Cactus ( Coryphantha sneedii var. leei) and Sneed Pincushion Cactus (Coryphantha sneedii var. sneedii) 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service New Mexico Ecological Services Field Office Albuquerque, New Mexico.

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USFWS. 1986. Sneed and Lee Pincushion Cacti (Coryphantha sneedii var. sneedii and Coryphantha sneedii var. leei) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 53 pp. https://ecos.fws.gov/docs/recovery_plan/860321b.pdf

USFWS. 2023. Lee Pincushion Cactus (Coryphantha sneedii var. leei) 5-Year Status Review: Summary and Evaluation. New Mexico Ecological Services Field Office. Albuquerque, New Mexico. 42 pp.

# SPECIES ACCOUNT: *Coryphantha sneedii var. sneedii* (Sneed pincushion cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/07/1979; Southwest Region (R2)

**Physical Description**

Both the Sneed and Lee pincushion cacti are many branched, forming tight clumps of up to 100 or more stems. Individual stems are cylindroid or spherical to club-shaped, 2.5-7.5 cm long (1.0-2.9 inches) and 1-3 cm in diameter (0.4- 1.2 inches) with tubercles up to 3mm long (0.12 inches). The tubercles are persistent and hard after fall of the spines. The spines hide the stem. The central spines are acicular, white, tipped with pink and brown, 3-14 cm long (1.2-5.5 inches) and about 6-17 per areole. The radial spines are white, 3-12 mm long (0.2-0.47 inches) and 35-90 per areole. The flowers are about 1.2 cm tall (0.5 inches) and of equal diameter, not opening widely; they are brownish-pink to pale rose with pink filaments and bright orange anthers. The fruits are greyish-green, or greenish tinged with brown, or rarely pinkish when ripe. They are clavate up to 1.5 cm long (0.6 inches) and 6 mm in diameter (0.24 inches). The seeds are reddish-brown, 0.7-1 mm long (.027-.039 inches), and 1.25-1.5 mm broad (.049-.059 inches) (Benson, 1982). In the Sneed pincushion cactus, the stems have spines that are not deflexed but spread parallel to the stem surface; the flowers are pale, or medium to rose, magenta; the seeds are 0.75 mm long (.03 inches), and 1.25 mm broad (.049 inches) (Benson, 1982). (USFWS, 1986)

**Taxonomy**

In the recent taxonomic publications (Kartesz 1999; Baker and Johnson 2000; Anderson 2001), both varieties of Coryphantha sneedii are placed in the genus Escobaria Britton and Rose. Baker and Johnson (2000) note that this genus is sometimes considered a subgenus of Coryphantha. Anderson (2001) uses the genus Escobaria in his book "The Cactus Family," stating that the International Cactaceae Systematics Group has accepted this genus. Further elucidation of the taxonomic relationships of the C. sneedii complex, including Escobaria guadalupensis, is needed in order to understand the distribution and abundance of C. sneedii var. sneedii (USFWS, 2015).

**Historical Range**

Coryphantha sneedii var. sneedii is a regional endemic along the Texas/New Mexico border (USFWS, 2015). It was historically known only from the Anthony Gap area of the Franklin mountains in Dona Ana County, New Mexico. (USFWS, 1986)

**Current Range**

It occurs in western Texas and nearby southern New Mexico (between El Paso and Las Cruces) (NatureServe, 2015). It possibly occurs in the Guadalupe Mountains; in Dona Ana and Eddy Counties, New Mexico, and El Paso County in Texas (USFWS, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 1986); sexual (inferred from USFWS, 1986)

**Breeding Season**

Adult: March - April, sometimes July - August (USFWS, 1986)

**Key Resources Needed for Breeding**

Adult: Rocks (USFWS, 1986; NatureServe, 2015)

**Reproduction Narrative**

Adult: A second blooming season has rarely been observed in July and August usually following summer rains. The best seedling survival is under rocks or deep in the cracks of rocks where seedlings are protected (USFWS, 1986; NatureServe, 2015). One type of stem remains small and probably serves to start new plants when they break off. Most Sneed pincushion cacti bloom after 3 - 4 years. Plants bud from March to April with the principal blooming period in April and fruit formation from august to November. Fruits from slaughter Canyon averaged about 18 seeds per fruit. With about 11 flowering stems per plant, about 140 seeds per plant are produced each year (USFWS, 1986).

**Habitat Type**

Adult: Terrestrial (USFWS, 1986; NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Desert and desert grassland (USFWS, 1986; NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 1,220-1,800 m elevation (USFWS, 1986; NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1986; NatureServe, 2015)

**Habitat Narrative**

Adult: It is restricted to limestone ledges and the rocky slopes of limestone mountains in desert and desert grassland habitats; 1,22 0- 1,800 m elevation; precipitation 19.7 - 40.0 cm/year; and grows in cracks on vertical cliffs or ledges. The limestones are generally hard, resistant to erosion, and support a sparse vegetation of low shrubs, some rosette-forming perennials, many cacti, and both annual and perennial herbs (USFWS, 1986; NatureServe, 2015).

***Dispersal/Migration***

**Dispersal**

Adult: Low to moderate (inferred from USFWS, 1986)

**Dispersal/Migration Narrative**

Adult: The fruits have a prune-like odor when ripe and attract rodents which are likely dispersal agents. Birds have been noted to feed on the fruits and should serve as dispersal agents. Some fruits crumble with age, and water disperses the seeds (USFWS, 1986).

***Population Information and Trends***

**Population Trends:**
Not available

**Number of Populations:**
20 (USFWS, 1986)

**Population Size:**
Possibly > 100,000 (USFWS, 1986)

**Population Narrative:**
There are 20 documented localities for this taxon. Heil and Brack (1985a) have estimated the total number of sneed pincushion cacti in Carlsbad Caverns National Park to exceed 100,000. This figure needs verification through quantitative sampling (USFWS, 1986).

***Threats and Stressors***

**Stressor:** Fire (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Most of the park has burned since 1941 (NPS 2005, map, p. 6). While lightning ignitions probably took place frequently in the Guadalupe Mountains, most fires were likely quite localized and less intense prior to fire suppression (NPS 2005). Fire suppression in many ecosystems creates more uniform fuel loads that support more landscape-scale high intensity fires (NPS 2005). However, specific impacts of wild and prescribed fire on C. sneedii var. sneedii are still inconclusive (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend. Munson et al. (20 14) predicts declines in vegetative cover including cacti in Chihuahuan Desert habitats due to climate change. Coryphantha spp. are likely to have experienced and rebounded from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species (USFWS, 2015).

***Recovery***

**Reclassification Criteria:**

Downlisting of the Sneed pincushion cactus to threatened can be initiated when:

1. Six or more secure populations are established with at least three each near the eastern (Guadalupe Mountains) and western (Franklin Mountains and southern Organ Mountains) limits of the plant's known range. Populations will be considered secure when land managing agencies, organizations or individuals have developed and implemented habitat management plans for the Sneed pincushion cactus. At a minimum, the plans should contain methods for securing populations against present and future potential threats, methods for accurately quantifying population sizes, and methods for monitoring populations to determine their stability, growth, or decline. (USFWS, 1986)

2. When the known number of plants in these six secure populations totals 20,000. (USFWS, 1986)

**Delisting Criteria:**
The Sneed pincushion cactus will be considered for delisting when:

1. All core populations demonstrate stable or increasing trends in abundance over a 20-year period. This will be based on periodic demographic trend monitoring and analysis implemented under the recovery actions. (USFWS, 2019)

2. Maintain a minimum of three geographically separated core populations for each species over a 20-year period. (USFWS, 2019)

3a. Maintain genetic diversity within all core populations as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)

3b. Maintain presence in 80 percent of subpopulations over 20-year monitoring period and outside of the core populations, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)

4. Develop and implement a Habitat Management Plan (HMP) for Sneed pincushion cacti conservation. (USFWS, 2019)

5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

**Recovery Actions:**
- Remove threats of collecting by enforcement of existing regulations. Because of the rarity of the Sneed pincushion cactus, the populations must be protected by enforcement of existing international, Federal, and State regulations. Determine the extent and impacts of collecting. Develop and implement a law enforcement strategy. Publicize successful law enforcement actions. (USFWS, 1986)
- Manage existing habitat for protection of the cactus. Habitat management for the Sneed pincushion cactus should be done through existing agency management procedures and through cooperation with private landowners. The following should be accomplished. Agencies should remain informed of the location and status of Sneed pincushion cactus

populations. Develop and implement habitat management plans for all populations on public lands. Seek cooperation of landowners to protect and maintain populations on private lands. (USFWS, 1986)

- Gather information for use in management. In-depth knowledge of the plant's growth, distribution, population biology and ecology is needed to understand habitat requirements. The knowledge gained can be used to help sustain and manage healthy natural populations. Study population biology and ecology. Inventory known populations and search for new populations in the Franklin and Guadalupe Mountains. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1986)
- Develop public awareness, appreciation and support for preservation of the Sneed pincushion cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential to the ultimate success of the foregoing recovery measures. (USFWS, 1986)
- Recommendations for Future Actions from 2015 5-Year Review: • Determine if the genus associated with this species needs to be changed from Coryphantha to Escobaria on all future Service documents. • Revise the recovery plan for these species to incorporate new information on taxonomy, biology, ecology, and threats with management recommendations. Objective and measurable recovery criteria for down and de listing of the species should be developed which address all listing factors relevant to this species. • Develop a Coryphantha sneedii var leei and C. sneedii var. sneedii multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. • Develop standardized survey and monitoring protocols for these species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. Incorporate fire and climate change factors into long-term monitoring data collection. • Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). • Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. • Provide legally grown seeds and plants of Coryphantha sneedii var. leei and C. sneedii var. sneedii, as the known populations allow, to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti thr.oughout its range. • Provide viable Coryphantha sneedii var. leei and C. sneedii var. sneedii seeds to a seed bank operating under the Center for Plant Conservation guidelines. • Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of these species. • Determine microhabitat needs of these species ("nurse" plants, pollinators, precipitation needs- amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2015)

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# SPECIES ACCOUNT: *Crotalaria avonensis* (Avon Park harebells)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/27/1993; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Avon Park harebells (Crotalaria avonensis) is a spreading, perennial herb with one to three moderately hairy, flowering stems that may grow 2 to 10 cm above the surface. It has a large taproot, up to 14 mm thick and 40 cm long. The leaves of this plant are 8 to 19 mm long, broadly elliptic or round, somewhat succulent, and coated with white or yellowish-white hairs. The stems terminate in flowering racemes. Flowering is from March until June. The flower, shaped like a typical pea flower, has a yellow corolla 8 to 9 mm long. The seed pods are inflated and 14 to 25 mm long. These pods are tan to grey or maroon, and can be nearly as long as the upright stems that hold them in place. The pods contain up to 18 seeds, chestnut to maroon in color and 3.4 to 3.8 mm long by 2.4 to 2.6 mm wide. The plant generally appears to resemble clusters of fuzzy grayish leaves hugging the ground and sometimes appears bushy (DeLaney and Wunderlin 1989). (USFWS, 1999)

**Taxonomy**

C. avonensis is a member of the pea family (Fabaceae/Leguminosae). This small herb with large seed pods was not named until 1989, evidently because very few specimens had ever been collected and they had not been examined by taxonomists. This species is most closely related to C. rotundifolia, a variable species that ranges from Virginia to Panama (DeLaney and Wunderlin 1989). Crotalaria is a very large, mostly tropical genus that includes a number of robust annual weeds, all with inflated “rattlebox” seed pods. It has been suggested that this endemic is a relic of the Miocene on the southern Lake Wales Ridge (DeLaney and Wunderlin 1989). (USFWS, 1999)

**Historical Range**

See Current Range.

**Current Range**

Avon Park harebells is one of the most narrowly distributed of the Lake Wales Ridge endemics, having only been identified at three sites in Polk and Highlands counties. Its distribution includes the Avon Park Lakes acquisition area and the Saddleblanket Lakes State Preserve in Polk County, and the Carter Creek acquisition area in Highlands County. (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated

**Breeding Season**

Adult: Flowering begins in mid-March and continues until June. (USFWS, 1999)

**Other Reproductive Information**

Adult: Flowering begins in mid-March and continues profusely until June. After flowering, this deciduous plant enters a vegetative phase, forming clusters of stems that give a clumped or rosette appearance. They are then dormant from late fall or early winter until March (DeLaney and Wunderlin 1989). Demographic information on pollinators, seed dispersers, and seed viability is lacking for this species. (USFWS, 1999)

**Reproduction Narrative**

Adult: Avon Park harebells are pollinated by insects, but visitation rates are very low. The plant is reproductively challenged, with less than 10 percent of flowers producing fruits. Seeds contribute to a persistent seed bank lasting at least three years. Seedlings have moderate survival and commonly begin flowering after 6-8 years (Menges et al. 2016). (USFWS, 2019)

**Habitat Type**

Adult: Scrub flatwoods rosemary scrub and pine scrub

**Environmental Specificity**

Adult: Very Narrow (USFWS, 1999)

**Habitat Narrative**

Adult: This species inhabits scrub communities found on the Lake Wales Ridge where it typically grows in full sun, on bare white sand, or in association with clumps of Cladonia lichens. However, it may also occur in the partial shade of other plants (DeLaney and Wunderlin 1989). It may also grow along trails, open edges, or previously disturbed roadbeds. The soils associated with this species have been classified as Archbold and Satellite sands (The Nature Conservancy 1991). Like other small scrub endemics, it appears to depend on bare patches of sand to become established. (USFWS, 1999)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: No information available (USFWS, 1999)

***Population Information and Trends***

**Number of Populations:**

4 (USFWS, 2023)

**Additional Population-level Information:**

The Avon Park harebells has a very narrow known historical distribution (Service 2007 and references therein). There are currently only four populations of Avon Park harebells, one of which is an introduced population. In 2012, 400 seeds and 84 transplants of C. avonensis were introduced to a site within management unit SL8 of the Silver Lake Tract of the Lake Wales Ridge Wildlife and Environmental Area (LWRWEA) (Smith et al. 2013, pp. 22, 25) ( Figure1). The site included both scrubby flatwoods and rosemary scrub, both being vegetation types with which the presence of Avon Park harebells is most often associated (Smith et al. 2013, p. 20) (USFWS, 2023).

**Population Narrative:**

Historically and currently, the species is known from just two populations. One population occurs partially in the unprotected Avon Park Lakes subdivision and continues to decline as vacant lots supporting the plant are developed (Menges et al. 2016). Part of this population is protected at a second site, The Nature Conservancy's Saddle Blanket Scrub Preserve. The second population is at the Florida Fish and Wildlife Conservation Commission's (FWC) Carter Creek unit of the Lake Wales Ridge Wildlife Management Area (LWRWEA). The unprotected Avon Park Lakes site hosts the largest number of plants, likely consisting of thousands. The Saddle Blanket site supported 531 plants in 2006 (Service 2007). The size of the Carter Creek population is unknown, but likely is in the thousands, based on Menges et al. (2016). Avon Park harebells has been reintroduced at two conservation sites which have to date been successful in establishing plants that have flowered and produced seed. The FNAI 2015 Element Tracking Summary (FNAI 2015) identifies 6 occurrences, 2 of these are protected at Saddle Blanket Preserve, and represent portions of the larger Avon Park Lakes population. Two others are FWC protected areas that represent the Carter Creek population. The final two occurrences represent unprotected portions of the Avon Park Lakes population. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

**Stressor:** land development (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat to Avon Park harebells in regard to Factor A is still land development. Projections expect an increase of up to 23 percent in the amount of developed land in central Florida, bringing the total to almost half of the land in the region (Carr and Zwick 2016, p. 23). While development directly decreases the amount of available habitat, it can also decrease the ability of land managers to utilize prescribed fire as a tool for maintaining the types of habitats in which Avon Park harebells are most often found (Melvin and McIntyre 2017, entire; Service 2019, p. 3). Development is also often associated with an increase in the use of various types of pesticides. The components of these pesticides can have a range of effects on insect pollinators, from inhibition of neurological or immune function to lethal outcomes (Sponsler et al. 2019, pp. 1020-1021). The loss of pollinators could be potentially devastating for Avon Park harebells, as they are dependent on pollination for successful reproduction (USFWS, 2023).

**Stressor:** Herbivory (USFWS, 2023)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Herbivory (under Factor C) has been shown to affect around 16 percent of plants annually, but these rates are highly variable between years (Menges et al. 2016, p. 565). The reduction of herbivory using protective cages around plants was also found to provide significant positive effects on survival, growth rates, and flowering, indicating that herbivory is a significant threat to Avon Park harebells (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Not developed. (USFWS, 1999)

**Delisting Criteria:**
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub and scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution of C. avonensis. This species' known distribution is isolated to Polk and Highlands counties. Additional surveys of scrub habitat with appropriate soils should be conducted in these two counties. A geographic nformation systems database should be developed to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review and in land acquisition activities. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or residential development. The remaining habitat is fragmented into small parcels and in many cases, isolated. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring needs to be developed for this and other listed scrub species to determine the effect of management actions. (USFWS, 1999)
- Provide public information about C. avonensis. It is important that governmental agencies, conservation organizations, and private land owners be appropriately informed about this species. (USFWS, 1999)
- Establish reclassification criteria. Once the population is stabilized, research and monitoring results may provide data necessary to develop reclassification criteria. (USFWS, 1999)

- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities • Continue applying prescribed fire when possible to maintain scrub habitat for Avon Park harebells. • Conduct further augmentation and introduction projects to expand the range of the species and increase the number of populations. • Acquire land within the range of Avon Park harebells and restore scrub habitat to these areas. Monitoring / Research Activities • Develop a consistent monitoring protocol to occur at regular intervals in areas that are occupied by Avon Park harebells and are accessible for survey.

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# SPECIES ACCOUNT: *Cucurbita okeechobeensis ssp. okeechobeensis* (Okeechobee gourd)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/11/1993; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A vigorous annual vine. Stems are nearly smooth. Leaves are alternate and paired, and have with long helical tendrils. The leaf blades have 5-7 shallow lobes. Flowers are cream-colored to nearly white, 6-7 cm long, narrowly bell-shaped. (NatureServe, 2015)

**Taxonomy**

Small (1922, 1930) originally described the gourds he found in the pond apple forest surrounding Lake Okeechobee as Pepo okeechobeensis. Bailey (1930) transferred the Okeechobee gourd to the genus Cucurbita, which includes pumpkins and squashes. Bailey (1943) subsequently described two new gourd species, C. martinezii and C. lundelliana. These two gourds were proven to be closely related to the Okeechobee gourd. Closely related gourds with cream-colored corollas (all others in the genus Cucurbita are bright yellow) are found in Florida and in Mexico, near the Gulf Coast. The Florida plants were described as the Okeechobee gourd (Bailey 1930) and the Mexican plants were designated (Bailey 1943) as the Martinez gourd (C. martinezii). However, Robinson and Puchalski (1980) showed through isozyme analysis that there was only a single allelic difference between the two varieties. The (ESA) does not allow Federal listing of disjunct populations of widespread plant species. Since the Mexican gourds are moderately abundant, and considering the findings of Robinson, the FWS originally opposed listing of the Okeechobee gourd. A later study by Walters and Decker-Walters (1991), also using isozyme analysis, showed a difference of just one allele. However, they calculated an estimated time since divergence of about 450,000 years between the Martinez and Okeechobee gourds, and concluded that they should be considered distinct at the subspecies level. Walters and Decker-Walters (1993) rearranged the nomenclature, designating the Florida gourds as Cucurbita okeechobeensis (Small) Bailey ssp. okeechobeensis, and assigning the Mexican gourds to the subspecies C. okeechobeensis ssp. martinezii (Bailey) Andres and Nabhan ex T. Walters and Decker Walters. The FWS concurred with this finding, and because the ESA allows protection of distinct subspecies, the Okeechobee gourd was subsequently listed as endangered. (USFWS, 1999)

**Historical Range**

Historically found on the southern shore of Lake Okeechobee, in Palm Beach County, Florida, and formerly in the Everglades area of Florida. (USFWS, 1999)

**Current Range**

Overall, the current range of Okeechobee gourd is limited to the shoreline and islands around the northwestern and southern portions of Lake Okeechobee in Glades and Palm Beach Counties and both sides of the St. Johns River from Lake Beresford south to Lake Monroe and along the western side of Lake Jessup along the Volusia and Lake County line and into Seminole County. These two populations are separated by over 100 miles and do not exhibit much genetic variation. Because Okeechobee gourd plants are difficult to count, we are unable to estimate the abundance of this subspecies. Surveys in 2007 indicated that the subspecies was present on four of the islands in Lake Okeechobee and on 12 sites along the St. Johns River. (USFWS, 2021) Most of the known occurrences in the Lake Okeechobee population are on public land, but extent of management is not reported. Consistent data showing fruit production at least every other year on Kreamer, Torry, and Ritta Islands and the southern Rim Canal of Lake Okeechobee have not been obtained. There are no stable, self-sustaining populations known to exist within the South Florida Ecosystem outside of Lake Okeechobee, except for the introduced population on private land west of Lantana in Palm Beach County. Finally, additional research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages is needed for evaluation with the water regulation schedule for Lake Okeechobee (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 1999)

**Reproduction Narrative**

Adult: Pollination occurs via insects. Based on closely related gourds, a variety of insects are likely to be available, including bees, flies, and squash beetles. Typically, male flowers greatly outnumber female flowers and where pollinators are rare, decreased fruit set may be observed (M. Minno, Eco Cognizant, Inc., personal communication 1998) (USFWS, 1999).

**Habitat Vegetation or Surface Water Classification**

Adult: Forested wetland, temporary pool, field (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Low water levels (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Originally found in swampy forests and hammocks on muck soils. Today, this species is restricted to disturbed areas that are not cultivated, such as ditch banks and wet road shoulders. It is sensitive to changes in hydrology and freezing. (NatureServe, 2015). Occurs at Lake Okeechobee and the other along the St. Johns River; limited to areas along the shoreline and a few islands in the lake and along the St. Johns River. Inhabits open organic soils exposed by low water levels (EPA, 2016). The gourd is ephemeral by nature, often only growing when habitat conditions are favorable, and its growth habit of climbing amongst the tree canopy precludes the ability to count individual plants. This subspecies employs a strategy of growing on open organic soils exposed by low water levels with little to no competition, producing numerous seeds with somewhat long viability, and experiencing vegetative decline when competition increases or water levels rise (Moyroud 2009b) (USFWS, 2009). The gourd readily climbs any plant that will provide a trellis; in both Lake Okeechobee and the St. Johns River, the Okeechobee gourd grows on elderberry (Sambucus canadensis) and buttonbush (Cephalanthus occidentalis). Around Lake Okeechobee, the gourd is frequently associated with alligator nests. These disturbed sites provide areas where competition is reduced and elevated areas that promote the growth of elderberry, button bush, and other erect bushes and shrubs. Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season.

***Dispersal/Migration***

**Dispersal**

Adult: Unknown (USFWS, 1999)

**Dependency on Other Individuals or Species for Dispersal**

Adult: Possibly march rabbits (USFWS, 1999)

**Dispersal/Migration Narrative**

Adult: High lake levels facilitate dispersal. Although the exact mechanism for seed dispersal of the Okeechobee gourd is unknown, Walters et al. (1992) suggest that Okeechobee gourds disperse by floating in water bodies (in canals and along the shore of islands in Lake Okeechobee); however, no information is available regarding the distances seeds may disperse. Walters et al. (1992) also indicate that marsh rabbits are the main terrestrial disperser of gourd seeds, but others suggest that rabbits are only a predator of these seeds and are unlikely to be significant seed dispersers (M. Minno, Eco-Cognizant, Inc., personal communication 1998) (USFWS, 1999).

***Population Information and Trends***

**Population Trends:**

> 95% decline (NatureServe, 2015)

**Species Trends:**

Declining (USFWS, 2009)

**Number of Populations:**

2 (USFWS, 2009)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

At least 50 gourds were found at one site by Walters and Decker-Walters in 1990-1991. In winter and early spring of 1990-1991 Walters and Decker-Walters found the Okeechobee gourd at 11 sites along the lake shores (Martin, 1992). The estimated population size is up to 1,000 individuals. The species Has already lost 95% of its former range (J.K. Small, 1930) (NatureServe, 2015). The species status is declining; fires destroyed no plants were found on the spoil islands that once supported substantial populations. The Okeechobee gourd is only found in Florida in two natural populations, one on Lake Okeechobee and the other along the St. Johns River. Very little genetic variation was observed within any of the three populations evaluated, and differences between populations were minor with nothing to differentiate between the Lake Okeechobee and St. Johns River populations of the Okeechobee gourd (Decker-Walters 2002c) (USFWS, 2009).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Continued habitat degradation and loss threaten the existence of Okeechobee gourd. Decker-Walters (2002c) stated that factors that reduce the availability of habitat (e.g., lack of fluctuation in water levels and aggressive weeds) pose a large threat to the subspecies. In addition, several factors related to human values (e.g., water storage, flood control, navigation) and ecological values (e.g., waterfowl, fisheries, littoral zone vegetation, water quality, snail kite recovery, and others) that affect management decisions can potentially conflict (Service 1999). At this time, the habitat seems stable along the St. Johns River; however, proposed water withdrawals for alternative public water supplies may affect suitability for the Okeechobee gourd (Minno 2009). Permanent inundation of suitable soils prevents germination of gourd seeds, and changes in water level management that would reduce the likelihood of low water can threaten the subspecies. Within the range of Okeechobee gourd in the Lake Okeechobee region, the human population is predicted to grow from nearly 11,000 to over 17,000 in Glades County between 2005 and 2060 and from approximately 1,270,000 to over 2,700,000 in Palm Beach County (Zwick and Carr 2006). Population growth is expected to increase water demands and recreational pressure on the lake. Within the range of the St. Johns River gourd population, the number of residents in Volusia County is projected to increase over the same time period from nearly 500,000 to over 940,000 and nearly triple in Lake County from just over 260,000 to more than 700,000 (Zwick and Carr 2006) (USFWS, 2009).

**Stressor:** Competition (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Okeechobee gourd plants are not strong competitors and are often outcompeted by more aggressive plant species (Decker-Walters 2002c). Weed competitors include moonflower, common reed (Phragmites australis), Virginia saltmarsh mallow (Kosteletzkya virginica), camphorweed (Pluchea sp.), melaleuca (Melaleuca quinquenervia), Sesbania sp., and Polygonum spp. (Decker-Walters 2002a; 2002c) (USFWS, 2009).

**Stressor:** Herbicide usage (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although necessary for control of exotic plants, herbicide use also poses a threat to the Okeechobee gourd. The occurrences at one of the sites along the St. Johns River were destroyed in 2005 where herbicide was sprayed, and the site is no longer suitable (Minno and

Minno 2005). Herbicides are routinely sprayed around Lake Okeechobee to keep waterways free of aquatic vegetation (USFWS, 2009).

**Stressor:** Disease (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Minno and Minno (1998) reported finding powdery mildew fungus (Sphaerotheco fuliginea), a hyperparasitic fungus (Ampelomyces quisqualis), mites (e.g., Bevipalpus sp., Propvioseius meridionalis, and Galendromus mcgregori), melonworm (Diaphania hyalinata), pickleworm (Diaphania nitidalis), sowbugs, grasshoppers, leaf-footed bugs, and scales (Saissetia neglecta) on leaves of the Okeechobee gourd along the St. Johns River. Little damage to the plants was observed except as a result of the powdery mildew fungus, melonworm, and pickleworm in which older leaves were killed and infected fruit was aborted (Minno and Minno 1998). During the 2002 survey on Lake Okeechobee's Torry Island, Okeechobee gourd plants appeared productive but unhealthy, and plants tested positive for several viruses, including cucumber mosaic virus, squash mosaic virus, and watermelon mosaic virus (Decker-Walters 2002a). Signs of viral infection (leaf puckering) were also seen on one of the FWC spoil islands, but few vines from the St. Johns River population exhibited signs of viral infection (Decker-Walters 2002a). The author believed that the Lake Okeechobee population may be affected by more diseases and insects as a result of local agricultural activities in the area, such as the production of squash, but suggested that reproduction may not be substantially affected (Decker-Walters 2002a) (USFWS, 2009).

**Stressor:** Predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Insect predation was observed on Okeechobee gourd plants on one of the FWC spoil islands on Lake Okeechobee in 2002 (e.g., striped cucumber beetle [Acalymma vittatum], pickleworm, and melonworm) (Decker-Walters 2002a). Extensive herbivory by marsh rabbits (Sylvilagus palustris) was observed on one of the FWC spoil islands on Lake Okeechobee and appeared to have devastated the plants on this island; the other spoil island seemed to be unaffected by herbivory (Decker-Walters 2002c). Decker-Walters (2002c) suggested that rabbits, as well as wild pigs (Sus scrofa), present a threat to the subspecies through predation of seeds. Plants in the St. Johns River population were healthier in 2002 and exhibited no signs of insect damage (Decker-Walters 2002a) (USFWS, 2009).

**Stressor:** Small population size (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small populations are susceptible to inbreeding depression, which compounds the effects of other threats, such as reduced resistance to herbivore damage and viral infections (Stephenson et al. 2004). Because Okeechobee gourds are ephemeral in nature, they tend to appear and disappear from sites, depending upon growing conditions (Service 1999). No stable core population remains south of the lake to ensure survival as a result of poor growing conditions (e.g., the permanent inundation of suitable soils as a result of water-level regulation)

(Service 1999). Even during natural environmental fluctuations, the subspecies may be more vulnerable to localized extinction because of small population sizes (Nee 2009). The presence of the large core population in the pond-apple forest around the lake in the past may have maintained viability of the ephemeral populations on the islands by providing a source for seeds (Nee 2009). Fewer individuals occur along the St. Johns River, making this small population more susceptible to catastrophic events than the lake population (Decker-Walters 2002a). Growing near water and in swamps helps to buffer plants from winter freezes which can kill exposed stems and leaves (Minno 2009). Because plants of the St. Johns River population survive mostly from stems growing along the ground or through dense vegetation, they may be more susceptible to the effects of freezes (Minno 2009) (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
1. The Okeechobee gourd is protected at all known sites within Lake Okeechobee (USFWS, 1999).

2. Plants on Kreamer, Torry and Ritta Islands and the southern Rim Canal of Lake Okeechobee produce fruit at each of these locations at least every other year (their [i.e., fruit] absence for a period of two or more consecutive years will violate this requirement) (USFWS, 1999).

3. The distribution of fruiting plants is expanded within Lake Okeechobee either by the discovery of additional sites or by translocation (USFWS, 1999).

4. One or two sites are established outside of the southeastern quadrant of Lake Okeechobee (outside of Palm Beach County) (USFWS, 1999).

5. A stable, self-sustaining population of the Okeechobee gourd is established within the South Florida Ecosystem outside of Lake Okeechobee (USFWS, 1999).

6. Measures of vitality are developed and monitored at each of the sites described above (USFWS, 1999).

7. Based on the results of research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages, the water regulation schedule for Lake Okeechobee is found not to jeopardize the continued existence of the Okeechobee gourd (USFWS, 1999).

Recovery Priority Number: 3

**Delisting Criteria:**
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factor A) (USFWS, 2019)

2. Populations (as defined in criterion 1) occur in marsh and swamp habitats and are distributed across the historical range of the species. (addresses Factors A and E) (USFWS, 2019)

3. Populations (as defined in criterion 1) must be protected via a conservation mechanism or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (addresses Factors A and E) (USFWS, 2019)

**Recovery Actions:**

- Maintain information on the distribution and status of the Okeechobee gourd. Conduct regularly scheduled surveys. Individuals should be encouraged to provide information on sightings of the Okeechobee gourd. (USFWS, 1999).
- Protect and enhance existing populations. Ensure that spraying for control of aquatic vegetation does not harm or kill Okeechobee gourd plants. Assess the effect of Melaleuca and Brazilian pepper control efforts (both cutand- squirt and aerial spraying methods); use techniques to avoid direct impact on Okeechobee gourd plants. Use provisions of section 7 of the ESA to protect the Okeechobee gourd. Augment natural populations of the Okeechobee gourd. (USFWS, 1999).
- Initiate research on the life history and genetics of the Okeechobee gourd. Test experimentally the viability of Okeechobee gourd seeds kept submerged for long periods (1 to 3 years). Characterize the range of soil conditions where the Okeechobee gourd currently grows and provide detailed mapping of soil types in southeastern Lake Okeechobee. Through field surveys, determine dates of germination under natural conditions. Test experimentally the effect of seasonally rising water level on the survival of young plants. After information is available from the research studies described above and the annual field surveys, conduct population viability and risk assessment studies particularly with respect to water regulation schedule alternatives for Lake Okeechobee. Investigate the role of animals in dispersing seeds of the Okeechobee gourd. Document the potential ecological relationship between the American alligator and the Okeechobee gourd. Investigate the genetic distance between the two known populations of the Okeechobee gourd. (USFWS, 1999)
- Monitor existing populations of the Okeechobee gourd. Determine the most effective approach to monitor the condition of the Okeechobee gourd. After determining the most effective methods and indices, onduct monitoring on an annual basis. (USFWS, 1999)
- Increase public awareness about the Okeechobee gourd. Public awareness can be addressed through a variety of strategies, including, but not limited to, classroom programs, newspaper and magazine articles, public information displays at boat ramps in Lake Okeechobee, and outreach to fishing and airboating clubs. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing Okeechobee gourd habitat. Restore areas to suitable habitat. Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation. Monitor habitat/ecological processes. Increase public awareness of ecological relationships, environmental stressors, and restoration activities in the South Florida Ecosystem. (USFWS, 1999)
- Conduct regular surveys to monitor growth and reproduction, especially from late November through mid-February when many trees are leafless and fruit are easy to see (USFWS, 2009).
- Monitor the spoil islands of Lake Okeechobee to evaluate how the plants respond in a restricted environment with other competitive colonizers and observe the establishment of the seed bank (USFWS, 2009).
- Monitor future translocation sites (USFWS, 2009).

- Continue research to evaluate temporal changes in the prevalence of the three viruses found and to determine the extent to which the fitness of Okeechobee gourd populations is being negatively impacted (USFWS, 2009).
- Conduct experiments on dry fruits from plants grown under controlled conditions (e.g., in the greenhouse) to explore the buoyancy of dried-fruit seeds in greater detail (USFWS, 2009).
- Continue to assess dormancy mechanisms and test viability limits through longer immersion periods of seeds (USFWS, 2009).
- Conduct buried seed experiments in Lake Okeechobee or St. Johns River soils (USFWS, 2009).
- Directly evaluate each gourd population for viral loads, determine the percentage of progeny that may carry the squash mosaic virus, and conduct off-site viral-inoculation experiments of progeny to evaluate degree of tolerance and reproductive impacts (USFWS, 2009).
- Re-evaluate the relationships amongst subspecies of Cucurbita okeechobeensis using modern molecular techniques and new morphological characteristics (USFWS, 2009).
- Continue research on fluctuations in abundance of the gourd in response to water conditions, particularly extended periods of high water, to determine the level of risk to the long-term survival of the subspecies (USFWS, 2009).
- Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation (USFWS, 2009).
- Conduct population viability and risk assessment studies, particularly with respect to water regulation schedule alternatives for Lake Okeechobee (USFWS, 2009).
- Eradicate exotic weeds (e.g., Ipomoea alba) in locations that support gourds and take care when planting native trees to prevent introduction of these weeds (USFWS, 2009).
- Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes (USFWS, 2009).
- Prevent cultural (i.e., human caused) eutrophication of lakes and marshes (USFWS, 2009).
- Avoid disruptive changes to the riparian habitat along the St. Johns River where the population occurs (USFWS, 2009).
- Ensure that water-level regulation is compatible with management needs of the Okeechobee gourd (USFWS, 2009).
- Ensure aquatic vegetation management practices are compatible with recovery of the subspecies (USFWS, 2009).
- Consider Okeechobee gourd and the creation of habitat in planning phases of Everglades restoration (USFWS, 2009).
- Restore habitat by planting pond apple and cypress where appropriate (USFWS, 2009).
- Establish a translocation protocol, locate potential sites, and translocate plants to identified sites (USFWS, 2009).
- Ensure that the St. Johns River and Lake Okeechobee populations are not grown together in collections to avoid hybridization. If hybridization is suspected, hybrid material should not be used for reintroduction (USFWS, 2009).
- Develop recovery criteria for the Okeechobee gourd population along the St. Johns River (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Surveys:  Conduct regular surveys to monitor growth and reproduction, especially from late November through mid-February when many trees are leafless and fruit are easy to see.  Monitor the spoil islands of Lake Okeechobee to evaluate how the plants do in a restricted environment with other competitive colonizers and observe the establishment of the seed bank.  Identify sites appropriate for future translocations. Conduct and monitor future translocation sites. These actions continue to be top priorities for the recovery of the Okeechobee gourd. Research:  Continue research to evaluate temporal changes in the prevalence of the three viruses found in association with the gourd, and determine the extent to which the fitness of Okeechobee gourd populations is being negatively impacted.  Conduct experiments on dry fruits from plants grown under controlled conditions (e.g., in the greenhouse) to explore the buoyancy of dried-fruit seeds in greater detail.  Continue to assess dormancy mechanisms and test viability limits through longer immersion periods of seeds.  Conduct buried seed experiments in Lake Okeechobee or St. Johns River soils.  Directly evaluate each gourd population for viral loads, determine the percentage of progeny that may carry the squash mosaic virus, and conduct off-site viral-inoculation experiments of progeny to evaluate degree of tolerance and reproductive impacts.  Re-evaluate the relationships amongst subspecies of Cucurbita okeechobeensis using modern molecular techniques and new morphological characteristics.  Continue research on fluctuations in abundance of the gourd in response to water conditions, particularly extended periods of high water, to determine the level of risk to the survival of the subspecies in the long term.  Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation.  Conduct population viability and risk assessment studies, particularly with respect to water regulation schedule alternatives for Lake Okeechobee. These actions continue to be top priorities for the recovery of the Okeechobee gourd. Management:  Eradicate exotic weeds (e.g., Ipomoea alba) in locations that support gourds and take care when planting native trees to prevent introduction of these weeds.  Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes.  Prevent cultural eutrophication of lakes and marshes.  Avoid disruptive changes to the riparian habitat along the St. Johns River where the population occurs.  Ensure that water-level regulation is compatible with management needs of the Okeechobee gourd.  Ensure aquatic vegetation management practices are compatible with recovery of the subspecies.  Consider Okeechobee gourd and the creation of habitat in planning phases of Everglades restoration.  Restore habitat by planting pond apple and cypress where appropriate.  Establish a translocation protocol, locate potential sites, and translocate plants to identified sites.  Ensure that the St. Johns River and Lake Okeechobee populations are not kept together in collections to avoid hybridization. If hybridization is suspected, hybrid material should not be used for reintroduction. These actions continue to be top priorities for the recovery of the Okeechobee gourd. (USFWS, 2021)

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# SPECIES ACCOUNT: *Dalea carthagenensis floridana* (Florida Prairie-clover)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/6/2017; Southeast Region (R4)

**Physical Description**

Dalea carthagenensis var. floridana is a short-lived (less than 8 years) perennial shrub that is 2.6 to 9.8 ft (0.8 to 3.0 m) tall with a light brown woody stem and non-woody, light brown or reddish branches. The leaves are composed of 9 to 15 oval, gland-tipped leaflets, and are gland-dotted on the underside. The flowers are in small loose heads at ends of hairy, glandular stalks, less than 0.4 in long. The flower color is white and maroon; each of the petals is different lengths and shapes. The fruit is a small one-seeded pod, mostly enclosed by the hairy, gland-dotted calyx (bracts at base of each flower). (USFWS, 2017)

**Taxonomy**

Chapman (1886, p.102) was the first to report this taxon in Florida, calling it the tropical Dalea domingensis, based on specimens collected on Key Biscayne. Small (1913, p. 89) accepted this epithet but included the taxon in the genus Parosela, making the plant P. domingensis. Rydberg (1920, p. 114) renamed the plant, calling it Parosela floridana, which was retained by Small (1933, pp. 694-695). Clausen (1946a, p. 85) reviewed the taxonomy of Florida and West Indian Dalea and considered them all to be the same species. Clausen (1946a, p. 85) also found that the name D. domingensis was a homonym of D. emphysodes, and published the name D. emphysodes ssp. domingensis. Clausen (1946b, p. 572) later discovered that his use of the name D. emphysodes was in error, and renamed the plants D. carthagenensis ssp. domingensis. Long and Lakela (1971, p. 478) accepted this usage. Barneby (1977), in a monograph of the genus, also found that Florida plants were distinct from West Indian plants, citing differences in leaf characters, naming the Florida species D. carthagenensis var. floridana. Wunderlin (1998) has followed this treatment.(USFWS, 2017)

**Historical Range**

The historical range of Dalea carthagenensis var. floridana includes Miami-Dade, Monroe, Collier, and Palm Beach Counties in Florida (USFWS, 2017).

**Current Range**

In Florida, the current range of Dalea carthagenensis var. floridana includes Big Cypress National Park (Monroe and Collier Counties), three Miami-Dade County conservation areas, and three additional unprotected lands within the Cutler Bay region of Miami-Dade County. (USFWS ,2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, perennial (USFWS, 2017)

**Lifespan**

Adult: Less than 8 years (USFWS, 2017)

**Reproduction Narrative**

Adult: Dalea carthagenensis var. floridana appears to be a short-lived (less than 8 years) perennial with a persistent seed bank (Maschinski et al. 2014, p. 45; Lange et al. 2016, p.15). D. carthagenensis var. floridana produces flowers from October to March and fruit ripen from November to April. The seed maturation period is January to May, with a peak in February and March. Larger plants can produce over 500 seeds. Seedling recruitment varies widely from year to year, with lower recruitment in drier years. Seedlings and juveniles experience rapid growth in their first 2 years. (USFWS, 2017)

**Habitat Type**

Adult: Pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats (USFWS, 2017)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest/Woodland, Woodland-Conifer

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire is extremely important to maintaining habitat for this species. (USFWS, 2017)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2017)

**Tolerance Ranges/Thresholds**

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

**Habitat Narrative**

Adult: Dalea carthagenensis var. floridana grows in pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats. It occurs in sparsely vegetated, well-lit, open areas that are maintained by disturbance. The dynamic nature of the habitat means that areas not currently open may become open in the future as a result of canopy disruption from hurricanes or invasive plant management, while areas currently open may develop more dense canopy over time, eventually rendering that portion of the hammock unsuitable for D. carthagenensis var. floridana. The species may also occur along roadsides within these habitats. The climate of south Florida where Dalea carthagenensis var. floridana occurs is classified as tropical savanna. (USFWS, 2017)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining; habitat loss continues to occur in the species' range. (USFWS, 2017)

**Species Trends:**
Declining (USFWS, 2017)

**Number of Populations:**
15 occurrences (USFWS, 2023)

**Population Size:**
Approximatly 1000 individuals in 15 populations, ranged from one to 372 plants per population (USFWS, 2023)

**Population Narrative:**
The extant populations occur in the Big Cypress National Park (Monroe and Collier Counties, Florida), in several conservation areas in Miami-Dade County (R. Hardy Matheson Preserve, Charles Deering Estate, Virginia Key, and Crandon Park) , and on three additional unprotected lands within the Cutler Bay region of Miami-Dade County (USFWS, 2017). Florida prairie-clover is a shrub in the pea family (Fabaceae) with a woody base that is endemic to the pine rockland, rockland hammock, marl prairie, and coastal berm habitats of southern Florida. The species is restricted to fifteen (15) populations found primarily in Miami-Dade County with some populations found in Monroe County. Although it has been extirpated from Palm Beach County, a population previously thought extirpated in Everglades National Park was rediscovered in 2018 (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands. (USFWS, 2017)

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2017)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

**Stressor:** Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

**Stressor:** Disease or predation (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Scale insects (Coccoidea) and Cassytha filiformis (love vine, a parasitic plant) infestations have been noted as parasites for Dalea carthagenensis var. floridana (Maschinski et al. 2015, p. 39) and may also influence populations of other listed pine rockland plant species. However, the best available data do not indicate that disease or predation is a threat to Sideroxylon reclinatum ssp. austrofloridense, Digitaria pauciflora, Chamaesyce deltoidea ssp. pinetorum, or Dalea carthagenensis var. floridana. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
Not defined.

**Delisting Criteria:**
Not defined.

**Recovery Actions:**
- Not defined.
- Conserve pine rocklands and suitable habitat through purchase or conservation easements.
- Restore understories by removing exotic plants or hardwoods.
- Provide regular prescribed burns to sites to maintain suitable habitat conditions.
- Monitor and manage the remaining small populations in Miami-Dade County.
- Consider and conduct augmentation and reintroduction, at suitable sites (Maschinski et al. 2005, p. 165).
- Conduct additional surveys in the Big Cypress region, including Florida Panther National Wildlife Refuge.
- Monitor known populations.
- Investigate ways to increase population viability.
- Study the introduced insect lobate lac scale to determine the extent of this threat and identify any necessary actions.
- Conduct studies to determine current level of genetic variation remaining in extant occurrences.
- Research presence and longevity of seed banks in different habitats.

***Conservation Measures and Best Management Practices:***
- RECOMMENDED FUTURE ACTIVITIES Recovery Activities This species does not have a final recovery plan. In the course of this status review, we have identified the following potential recovery activities which are included below. Ɣ Continue regular fire prescriptions (every 3-7 years) at R. Hardy Matheson Preserve. Ɣ Identify other occurrences which may be candidates for prescribed fire. Monitoring / Research Activities In addition to the continued monitoring of known occurrences, new occurrences ought to be sought out either through broadscale surveys or restoration. Ɣ Identify new occurrences through broadscale surveys for extant Florida prairie clover populations. This effort may be aided by education. By teaching the public to identify and report this species through widely available platforms like iNaturalist new occurrences may be identified. Restoration efforts should work to identify new mechanisms of management and areas of potentially suitable habitat. Ɣ Identify methods to mimic prescribed fire where the application of fire is impractical, like publicly owned conservation lands embedded within urban communities. Ɣ Identify open mesic to xeric shrub communities (pine rockland, marl prairie, coastal strand, and ecotones between each of these habitats and rockland hammocks) with a high probability of persistence given sea-level rise projections. Pursue the sustained restoration and preservation of these sites be they preserves, parks, or private property. ż One such location may be the Richmond Pine Rockland (USFWS, 2023).

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# SPECIES ACCOUNT: *Dalea foliosa* (Leafy prairie-clover)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/1/1991; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A stout perennial herb, 2-8 dm tall, with several stems arising from a hardened root crown. Dense spikes of small purple flowers appear most abundantly from late July to early August, but may continue to bloom sporadically into September. (NatureServe, 2015)

**Taxonomy**

Dalea foliosa, a member of the legume family or Fabaceae, was first described as Petalostemonfoliosus by Asa Gray in 1868 (Gray 1868). The generic name Petalostemum A. Michaux, first published in 1803, has been conserved over the earlier Kuhnistera Lamarck of 1789, with the spelling of Petalostemon also conserved over the original Petalostemum (Greuter et al. 1988, Farr et al. 1979). Because the gender of Petalostemon is neuter, the correct name of leafy prairie-clover under this genus is Petalostemonfoliosuin A. Gray (USFWS, 1996).

**Historical Range**

The distributional center for Dalea foliosa is the limestone cedar glades of central Tennessee and northern Alabama, where the species is considered nearly endemic (Baskin and Baskin 1973) (USFWS, 1996).

**Current Range**

Mesic dolomite river-terrace prairies of northeastern Illinois, Middle Tennessee Limestone Glades, northern Alabama Limestone Glades. In Tennessee, occurs on only 13 USGS 7.5' quads in seven counties of the Central Basin. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Sexual, autogamy (USFWS, 2015)

**Lifespan**

<u>Adult:</u> 8 years (USFWS, 1996)

**Dependency on Other Individuals or Species**

<u>Adult:</u> Bombus spp. based on closely related species (USFWS, 1996)

**Breeding Season**

<u>Adult:</u> July - August (USFWS, 1996)

**Key Resources Needed for Breeding**

Adult: Insect pollinators; moist soil (USFWS, 1996)

**Reproduction Narrative**

Adult: Produces flowers July to August; seeds ripen by early October. Bumblebees, small bees, syrphrid flies have been observed visiting flowers. Bombus species are probably required for successful seed set (based on other species in the same genus). Emergence occurs in March for existing plants. Seeds germinate in April and have several leaves by May. Molano-Flores (2005) determined that Dalea foliosa is self-compatible and that self-pollination (i.e., autogamy) can occur in this species, despite that fact that it is protandrous (USFWS, 2015). Dalea foliosa is short-lived and has no capacity for vegetative spread (Baskin and Baskin 1973; Schwegman and Glass, unpublished data). Plants may take up to 3 years to flower under field conditions (Baskin and Baskin 1989). Adequate soil moisture is critical for seedling establishment. The oldest living plants monitored to date have reached 8 years (n=2) and 7 years (n=2) of age (Schwegman and Glass, unpublished data). Mature plants may not flower every year (USFWS, 1996).

**Habitat Type**

Adult: Terrestrial, riverine, palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Spring, herbaceous wetland, riparian, barrens, grassland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full sun, periodic fire (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 550-700 ft. elevation (USFWS, 1996)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Occurs in Tennessee and Alabama in open, thin-soiled limestone glades and limestone barrens. In Tennessee, the plants occur on wet calcareous barrens and moist prairies or cedar glades, usually near a stream or where some seepage from limestone provides seasonal moisture. Associates in these habitats are rose-pink (Sabatia angularis), and black-eyed Susan (Rudbeckia triloba). The species is disjunct in Illinois, where it is restricted to thin-soiled (< 4.5 dm), wet or moist, open dolomite prairies on river terraces in the northeastern part of the state. The plants require full sun and low competition for optimum growth and reproduction; periodic fire is needed to maintain these conditions. (NatureServe, 2015). Occurs in shallow silt to silty clay loams over flat, often fractured horizontally bedded limestone or dolomite at 550-700 ft. elevation.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are dispersed by wind, gravity, small mammals, and birds. Seeds are dispersed from late fall to early spring

***Population Information and Trends***

**Population Trends:**

> 45% decline (NatureServe, 2015)

**Species Trends:**

Stable to declining (USFWS, 2015)

**Number of Populations:**

63 total (USFWS, 2022)

**Population Size:**

Unknown (NatureServe, 2015)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

This species has declined by over 45% from historical occurrences due to the destruction of habitat, overgrazing, and habitat loss from encroachment by woody plants (Thompson et al. 2006). There are approximately 60 extant occurrences presently recorded, but about 25 occurrences are of poor or very poor quality. There are currently known extant occurrences in 3 states: 50 in Tennessee, 4 in Alabama, and 8 in Illinois. In Tennessee, only 10 occurrences are ranked as good or excellent (EO data in the NatureServe central database as of February 2012). The Tennessee records occur on only 13 USGS 7.5' quads in 7 counties of the Central Basin. Long-term survival is fair to poor unless more sites can be maintained with mowing or ecological burning (NatureServe, 2015). The species status is stable in IL and TN; monitoring data from these states display substantial interannual variability in total numbers of plants as well as for multiple life history stages. The species has declined in Alabama, where only two extant populations are known to exist. Low levels of genetic variation were documented in this species by Edwards et al. (2004) (USFWS 2015). Range wide Dalea foliosa occurs within 63 populations. Of those, 50 are located in central Tennessee, while 11 are disjunct in northeast Illinois and 2 in northwest Alabama (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonetheless, several of the threats to Dalea foliosa habitat identified in the recovery plan still have the potential to affect this species even in protected sites, namely, degradation due to invasive exotic or native species encroachment, illegal outdoor recreational vehicle (ORV) use, and incompatible management of utility rights-of-way. Despite its protected status a

relatively large population was essentially lost to habitat destruction at the Sneed Road Cedar Glade DSNA site in Tennessee, which at the time was a Registered Natural Area owned by The Nature Conservancy. This site was severely impacted in 2001, apparently by activities associated with development of adjacent property that resulted in placement of fill material on areas where Dalea foliosa occurred. This population contained an estimated 300 or more plants in 1980, but had declined to 53 plants in 2000, despite removal of the fill material, and only 6 plants were observed there in 2003 (TDEC 2005a). Barbers and Wilhelm (2005) noted that the population at the Dellwood Park West site is periodically inundated by floodwater from the adjacent Illinois and Michigan Canal, which poses a threat to this population and to habitat restoration efforts at this site (USFWS, 2015).

**Stressor:** Succession (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The main threat to protected sites comes from the potential for either exotic or native, invasive plant species to displace Dalea foliosa from otherwise suitable habitat. Through the process of vegetation succession in the absence of disturbance (e.g., fire), native herbaceous and woody species also can pose a threat. Prescribed fire is used to manage most of the sites where Illinois populations occur on public lands. Efforts to develop a fire management program for lands managed by TDEC have met limited success, owing to insufficient funding, staff turnover, and challenges associated with burning in the urban interface (USFWS, 2015).

**Stressor:** Herbivory (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The recovery plan (Service 1996) identified intense livestock grazing and selective browsing by eastern cotton-tail rabbits (Sylvilagus floridanus) and white-tailed deer (Odoicoileus virginianus) as threats to D. foliosa. Molano-Flores (2004) observed herbivory at the Midewin NTP in 2002, with little evidence of recovery of affected plants during that growing season. McNicoll and Sivicek (2005) recorded evidence of damage caused by browsing animals in approximately 21 percent of the adult plants they counted at Keepataw Forest Preserve in 2005, and 483 of the 607 plants at Romeoville Prairie Nature Preserve in 2005 were impacted by herbivory (Key 2005). Taft et al. (2010) reported herbivory affecting 31.3 percent of adult plants at Keepataw Forest Preserve in 2010, which had increased from 12.5 percent in 2009. Because of the threat of browsing to seedlings, cages were used to protect at least a portion of the seedlings at each site where plantings occurred in 2008 as part of a project to reintroduce or augment populations (Redmer and Lah 2008) (USFWS, 2015).

**Stressor:** Small, isolated populations (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Edwards et al. (2004) found populations of Dalea foliosa "…were quite genetically depauperate" and that the isolated populations in Alabama and Illinois contained only a subset of the variation found in Tennessee populations. Measures of both polymorphism and expected heterozygosity were lower than reported averages for other endemic plant species (Hamrick and

Godt 1989 in Edwards et al. 2004). Population sizes tend to be small throughout the range of D. foliosa, which combined with spatial isolation could result in genetic drift exerting a dominant influence on population genetic structure. Increased incidence of inbreeding also is a risk associated with small populations, which can lead to a loss of fitness (i.e., inbreeding depression). These factors combined place many D. foliosa populations at a potentially heightened risk of localized extinction (Barrett and Kohn 1991). The ability of populations to adapt to environmental change is dependent upon genetic variation, a property of populations that derives from its members possessing different forms (i.e., alleles) of the same gene (Primack 1998). Small populations occurring in isolation on the landscape can lose genetic variation due to the potentially strong influence of genetic drift, i.e., the random change in allele frequency from generation to generation (Barrett and Kohn 1991). Smaller populations experience greater changes in allele frequency due to drift than do larger populations (Allendorf and Luikart 2007). Loss of genetic variation due to genetic drift heightens susceptibility of small populations to adverse genetic effects, including inbreeding depression and loss of evolutionary flexibility (Primack 1998) (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Both the final rule listing Dalea foliosa as endangered (Service 1991) and the recovery plan (Service 1996) identify drought as a threat to populations of this species. The recovery plan points out that the species possesses some life history traits (e.g., formation of persistent banks, dormancy response to drought) that enhance its resilience to this threat. However, threats associated with small population sizes and diminished genetic variation could combine with increased drought severity to diminish the species’ resilience to this threat over time, leading to substantial declines through the cumulative loss of small, isolated populations. In the face of accelerated climate change, it is imperative that effective monitoring programs are instituted throughout the range of the species in order to track trends in the face of potentially more severe (i.e., frequent, intense, or prolonged) drought conditions. In a study using count data of seedlings/juveniles, non-flowering adults, and flowering adults from Midewin NTP, all stages and total annual census were positively correlated with snowfall. Flowering plants negatively correlated with fall days below 0 oC, seedlings negatively correlated with mean February temperature, and non-flowering adults positively correlated with September precipitation (Molano-Flores and Bell 2012). When the authors incorporated predicted effects of climate change, using projections for mean February temperature and September precipitation in September, into regression models, the majority of the climate models predicted that population size would decrease from the mean population size of 188 plants from 1997-2008 (Molano-Flores and Bell 2012). This provides further evidence to suggest that climate change presents an increased risk of extinction for Dalea foliosa, especially for smaller populations and those with reduced genetic variation, which could limit potential for adapting to changing conditions (USFWS, 2015).

**Stressor:** Herbivory (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Available data indicate that herbivory by eastern cottontail rabbit (Sylvilagus floridanus) and white-tailed deer (Odoicoileus virginianus) herbivory continue to threaten the species. The recovery plan (Service 1996) identified livestock grazing and selective browsing by eastern cottontail rabbits and white-tailed deer as threats to Dalea foliosa. We currently are not aware of any sites where livestock grazing poses a threat to the species (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
1. A minimum of three populations ranked as high viability are protected and managed in Alabama for a minimum of 5 years. (USFWS, 1996)

2. A minimum of three populations ranked as high viability are protected and managed in Illinois for a minimum of 5 years. (USFWS, 1996)

3. A minimum of twelve populations ranked as high viability are protected and managed in Tennessee. (USFWS, 1996)

4. Restored populations persist at high or moderate viability for a minimum of 10 consecutive years. (USFWS, 1996)

Recovery Priority Number: 5

**Delisting Criteria:**
1. A minimum of three populations ranked as high viability are protected and managed in Alabama for 10 years (USFWS, 1996).

2. A minimum of three populations ranked as high viability are protected and managed in Illinois for 10 years (USFWS, 1996).

3. A minimum of twelve populations ranked as high viability are protected and managed in Tennessee. (USFWS, 1996)

4. Restored populations persist at high or moderate viability for a minimum of 10 consecutive years (USFWS, 1996).

**Recovery Actions:**
- Identify and prioritize protection. management. and restoration needs for all high- and moderate-viability populations (and low-viability populations with recovery potential for each geographic region in order to achieve the recovery criteria. Of the21 known or presumed extant leafy prairie-clover populations only 2 (10 percent) rank as high viability, 7 (33 percent) rank as moderate viability, and 12 (57 percent) rank as low viability. To meet the recovery criteria established in this plan, recovery activities need to be implemented for at least 18 (86percent) populations. This includes all nine populations of high and moderate viability, at least five populations of low viability with recovery potential, and an estimated four new populations. One or more recovery actions can increase a population from a low or moderate viability to a high viability. Key management needs or threats are identified for all critical sites by geographic region below and are summarized in Table 10 of the Recovery

Plan. More detailed site recommendations are also provided. (USFWS, 1996)
- Initiate and complete preserve design and implement the protection and management required to meet recovery criteria. Develop preserve designs. Implement protection. Develop management plans. (USFWS, 1996)
- Develop and implement population monitoring programs. A monitoring program should be designed to gauge the status of naturally occurring populations over a period of time and to evaluate the status of population recovery and restoration actions. By relating the data to changing environmental or management conditions, the monitoring program will help determine if and what management or recovery actions are needed for population maintenance. Populations can be monitored by tracking the total census count and by using sampling or demographic dataand should at least include accurate mapping of locations (patches). Demographic monitoring is most important in the initial stages of population restoration. Tracking of individual survivorship, reproductive status, and recruitment will help determine ifand how these variables are related to changes in successional stage, management actions, or environmental stochasticity (sensu Shaffer 1981); e.g., drought. At a minimum, monitoring data for all populations should include growth stage (seedling,juvenile, mature, or dormant), flowering frequency, rate of herbivory, number offlowering and/or fruiting ramets per plant, and observations of general vigor. Reproductive potential and seed output can also be estimated. (USFWS, 1996)
- Conduct research needed to enhance recovery efforts. (USFWS, 1996)
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of leafy prairie-clover could greatly encourage landowner assistance in conservation efforts. However, informational material should not identify the plant’s precise locations in order to discourage vandalism to, or collection of, wild populations. (USFWS, 1996)
- Recommendations for Future Actions from 2015 5-Year Review: A. The Service should coordinate with Drs. Brenda Molano-Flores (pers. comm. 2008) and Tim Bell on their efforts to develop a population viability analysis for D. foliosa across its entire range. If this effort were successful across the species range, it could be used in conjunction with the existing PVI to provide a better estimation of the extinction risk faced by individual populations and the species as a whole. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: B. Increase frequency of monitoring in Tennessee and Alabama populations, and standardize methods throughout the species’ range, as feasible. Feasibility is a constraint in Tennessee, owing to the large number of populations and the fact that TDEC is the only agency currently monitoring this species at most sites in the state. The Service should work with TDEC to increase capacity by participating in monitoring activities. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: C. Increase use of prescribed fire, or other techniques, for maintaining open conditions with limited competing vegetation in areas with sufficient soil depth to support D. foliosa. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: D. Determine the number of populations that are represented by element occurrences throughout the range of D. foliosa. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct entities. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. It appears that the only circumstance in

Illinois where such a determination might be warranted is the case of the two “populations” at the Waterfall Glen Preserve in DuPage County (Appendix B), which might be more appropriately treated as a single population for recovery purposes. Most of the Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations. (USFWS, 2015)

- Recommendations for Future Actions from 2015 5-Year Review: E. Continue efforts to reintroduce/augment Illinois populations. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: F. Collect data to calculate a current PVI for each protected population, in order to evaluate the species’ status with respect to recovery criteria. (USFWS, 2015)
- The Service should coordinate with Drs. Brenda Molano-Flores (pers. comm. 2008) and Tim Bell on their efforts to develop a population viability analysis for D. foliosa across its entire range. If this effort were successful across the species range, it could be used in conjunction with the existing PVI to provide a better estimation of the extinction risk faced by individual populations and the species as a whole (USFWS, 2015).
- Increase frequency of monitoring in Tennessee and Alabama populations, and standardize methods throughout the species’ range, as feasible. Feasibility is a constraint in Tennessee, owing to the large number of populations and the fact that TDEC is the only agency currently monitoring this species at most sites in the state. The Service should work with TDEC to increase capacity by participating in monitoring activities (USFWS, 2015).
- Increase use of prescribed fire, or other techniques, for maintaining open conditions with limited competing vegetation in areas with sufficient soil depth to support D. foliosa (USFWS, 2015).
- Determine the number of populations that are represented by element occurrences throughout the range of D. foliosa. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct entities. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. It appears that the only circumstance in Illinois where such a determination might be warranted is the case of the two “populations” at the Waterfall Glen Preserve in DuPage County (Appendix B), which might be more appropriately treated as a single population for recovery purposes. Most of the Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations (USFWS, 2015).
- Continue efforts to reintroduce/augment Illinois populations (USFWS, 2015).
- Collect data to calculate a current PVI for each protected population, in order to evaluate the species’ status with respect to recovery criteria (USFWS, 2015).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Since preliminary genetic testing reveals that genetic diversity in all Dalea foliosa populations is limited, evaluate whether a genetic management plan for potential movement of individuals between populations, potentially between states, is needed. • Determine the number of populations that are represented by element occurrences throughout the range of Dalea foliosa. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct populations. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. The two Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations. All Illinois populations are distinct. • Across the species range, plan and implement strategies to increase resiliency of populations that are ranked as having low or moderate viability, prioritizing those on publicly protected lands or where landowners are willing to enter into conservation agreements for the species. • Standardize annual monitoring methods by applying the PVI framework from the recovery plan throughout the species' range (USFWS, 2022).

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# SPECIES ACCOUNT: *Deeringothamnus pulchellus* (Beautiful pawpaw)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/27/1986; Southeast Region (R4)

**Physical Description**

The beautiful pawpaw is a low-growing, diminutive shrub of the Annonaceae family rarely exceeding 0.5 m in height. The stems may be annual or perennial and arise from a stout taproot that averages 32.5 cm long and is about 2.5 cm wide at its widest point. The leaves are alternate, leathery, deciduous, and 4.0-7.0 cm long with slightly revolute (curving under) margins. The leaf shape is oblong to oblong-ovate or spatulate, with a rounded or notched end. The base of the leaf is rounded or tapering to a 2.0-4.0 mm long petiole. Young leaves have sparse, short, red hairs on both sides. Maturing leaves become dark green to glossy green above and paler green below. The flowers of this species occur singly in leaf axils and have between 6 and 10 creamy-white petals that are about 2.0-3.0 cm long. The fruits are fleshy, smooth and yellow-green when ripe and are 4.0-7.0 cm long. The seeds are dark brown and from 1.0-1.5 cm long. (USFWS, 1999)

**Taxonomy**

The species was first named and described by John K. Small as the only species belonging to the genus Deeringothamnus and separated from the genus Asimina by its "dimorphous sterns, the flat or depressed receptacle, and the narrow nearly uniform unsculptured petals" (Small 1924). Rehder and Dayton (1944) discussed placing the species in the genus Asimina. Because the use of the combination Asimina pulchella did not meet nomenclatural rules, they retained the Deeringothamnus pulchellus name. A subsequent treatment of taxonomy is consistent with that of Small (Kral 1960). However, Ward (2001) suggested that, due to the presence of forms that appear to be intermediates between D. pulchellus and its congener D. rugelii, they should be treated as a single species and varieties should be used to distinguish the two forms. According to Ward's (2001) assessment, beautiful pawpaw should be named D. rugelii var. pulchellus. The scientific community has not fully embraced this taxonomic change, and Ward also now considers them as two separate species (Norman 2003, 2008). The Integrated Taxonomic Information System (2009) does not indicate any formal changes to the name D. pulchellus. (USFWS, 2009)

**Historical Range**

Historically occurred on poorly drained sands of slash and longleaf pine- saw palmetto flatwoods in Lee and Charlotte Counties in southwestern Florida and was also found in Orange County east of Orlando. (USFWS, 2009)

**Current Range**

In Florida, in Charlotte, Lee, and Orange Counties. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Research on the beautiful pawpaw has been conducted in the areas of phenology, pollination, reproductive structures, breeding system, germination, and hybridization (Norman 2003). Available information suggests that this species has poor fertilization, seed-setting, germination, and recruitment rates. Pollinators for this species are few, but those noted are a tumbling beetle (Mordella atrata) and two species of thrips (Frankliniella bispinosa and Thrips hawaiiensis) (Norman 2003). The reproductive biology of the species is not thoroughly understood, but the plant is thought to reproduce entirely by seed. Gopher tortoises (Gopherus polyphemus) may be an important seed disperser. Although not investigated in detail, ingestion of the seeds by gopher tortoises or other herbivores may be important for seed germination. However, seeds have been germinated without this type of treatment. On Pine Island, Lee County, plants begin flowering by mid-March and are at the peak of flowering the last week of April. Likewise, flowering was observed in Orange County in mid-March and lasted for 6 weeks (Norman 2003). Fruit is likely produced and dispersed during the summer. Because the species is thought to be long-lived, reproductive success is not critical every year (Service 1999). Other than follow-up monitoring during the first year after transplant of three transplanted populations, no long-term estimates of survival have been obtained for the species (Service 1998; Preston et al. 2004). No follow-up data have been collected. Additionally, no information has been reported on survival of individuals in natural occurrences, and life history stage and population structure data have not been collected. Limited experiments with seed collected from Orange County reported very low seedling survival, suggesting that the species may rely on a mycorrhizal fungal association to promote seedling survival (Norman 2009).

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: The species occurs in two disjunct locations in central and southwest Florida. It grows in xeric, mesic, and hydric pine flatwoods in western Charlotte and Lee counties and eastern Orange County. Soils in these habitats are poorly drained, although slight elevations provide better drainage than surrounding soils that are wetter. In Lee County, the pawpaw exists on Pine Island, where it occurs in pristine and modified flatwoods, on road edges, and on mowed lots. In Charlotte County it is found in an area broadly known as the Charlotte Harbor flatwoods and includes sites along State Road 765 and FWC's Cecil M. Webb Wildlife Management Area.

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

35 (USFWS, 2021)

**Population Size:**

~5,000

**Population Narrative:**

Surveys have been conducted intermittently in the past, but trend data are difficult to assess because surveys have generally only assessed a few occurrences at any one time and new occurrences have been discovered. Based upon the most comprehensive data available, there are currently thought to be approximately 5,000 pawpaw plants (FNAI 2008). The number of plants ranges from 1 to 2 plants on some sites to over 1,000 individuals on 3 sites (FNAI 2008). Nearly one-third of the occurrences were comprised of 15 or fewer pawpaws (FNAI 2008). Beautiful pawpaw is a long-lived shrub that occurs in open mesic flatwoods habitat within a disjunct range, occurring in Orange, Charlotte, and Lee Counties, Florida. The populations are fragmented and isolated within the range. Currently, there are an estimated 35 populations, though it is difficult to determine the status of each given the lack of monitoring. Consistent annual surveys are needed to evaluate long-term population trends and additional studies need to be completed on long-term survival, reproductive patterns, and population structure. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Continued habitat loss, fragmentation, and changes in land use threaten the existence of beautiful pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. One of the occurrences in Orange County has been extirpated (FNAI 2008). The property where this occurrence was reported was located adjacent to houses, the site was overgrown with Brazilian pepper (Schinus terebinthifolius), and trash was deposited in the area (FNAI 2008). It is likely that the plants were either crushed by debris or the habitat degraded to the point of being unsuitable for the species. (USFWS, 2009)

**Stressor:** Inadequacy of existing regulatory mechanisms
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The ESA provides protection for this species and its habitat through section 7. The beautiful pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. Lee County offers some protection for the beautiful pawpaw through a listed species ordinance which requires mitigation for adverse effects to State and federally listed species (Lee County 1998). However, this ordinance does not apply to agricultural lands or those being re-zoned for agriculture, and part of the threat of habitat loss where pawpaws occur is a result of clearing for agricultural purposes. In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with pawpaws have been developed. Because this plant occurs in habitat which is desirable real estate for development along the southwestern coast and inland near Orlando, this species remains

vulnerable to development pressures where it occurs on private property. (USFWS, 2009)

**Stressor:** Inadequate fire or land management (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs in pine flatwoods habitat, which is typically maintained by fire. This species is adapted to live in pine flatwoods habitat where frequent ground fires are not hot enough to kill mature pine trees but do remove or thin understory vegetation and reduce competition with larger grasses and shrubs. During the first growing season after fire, the beautiful pawpaw takes advantage of newly-created openings by flowering and setting fruit (Service 1999). Therefore, land management practices such as prescribed fire are very important to maintaining and working towards recovery of the beautiful pawpaw. - Lack of management is a concern on some protected sites. Vegetation restoration and management programs are costly, and the availability of resources is never assured; therefore, habitat degradation and modification from inadequate management even on protected lands remains an imminent, though moderate, threat. - On many privately owned sites, fire has historically been suppressed, and habitat has not received regular maintenance. Where this species occurs on fragmented landscapes interspersed with development, burning may be unlikely due to proximity to neighbors. In areas that cannot be readily burned, mowing is sometimes used as a management strategy. In mowed habitat, the growth habit of this species is more prostrate with woody stems lying on the ground, while in fire-maintained habitat, it grows more erect with arching sterns. (USFWS, 2009)

**Stressor:** Invasive plant species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the absence of site maintenance, a threat to pawpaws is the establishment of invasive plant species such as Brazilian pepper, meialeuea (Melaleuca quinquenervia), and earleaf acacia (Acacia auriculifbrinis). However, herbicides used to control overgrowth, if not properly applied, also may pose a threat to the beautiful pawpaw. (USFWS, 2009)

**Stressor:** Natural events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species' limited distribution and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. However, Hurricane Charley crossed the northwest portion of the species' range in Lee and Charlotte Counties in 2004, and no apparent damage occurred to the beautiful pawpaws (Woodmansee and Barry 2007). During this hurricane, storm surge did not impact the occurrences but could in cases where storm surge is greater. The possibility of future hurricanes and tropical storms striking Florida is likely; this threat is expected to continue. . (USFWS, 2009)

**Stressor:** All-terrain vehicls and feral hogs (USFWS, 2009)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** A threat identified when the species was listed was damage by allterrain vehicles in at least a portion of the species' range. It is presumed that this threat continues on occurrence sites where access is not restricted. Feral hogs (Sus scrofa) may also pose a threat to beautiful pawpaw plants. (USFWS, 2009)

*Recovery*

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of D. pulchellus, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain pine flatwoods to support D. pulchellus (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**
1. When at least 30 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)

2. When populations (as defined in criterion 1) occur in pine flatwoods habitat distributed across the historical range of the species in order to maintain and enhance the species geographic patterns of genetic diversity. (Factor A) (USFWS, 2019)

3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, E) (USFWS, 2019)

**Recovery Actions:**
- 1. Determine current distribution of D. pulchellus. - Conduct surveys for D. pulchellus. - Maintain distribution of known populations and suitable habitat in GIS database. Use GIS to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the Florida Natural Areas Inventory database. (USFWS, 1999)
- 2. Protect and enhance existing populations. - Acquire or otherwise protect habitat through acquisition, conservation easements, or agreements with landowners. - Protect populations on public lands. Develop management guidelines that allow for a fire regime that includes a mosaic of successional stages. - Use local or regional planning to protect habitat. Utilize

available regional and county planning processes to encourage protection of suitable unoccupied and habitat occupied habitat of D. pulchellus. Protecting this species on private property in Lee County is possible due to county ordinances that require conservation of listed plants. - Enforce available protective measures. Use local, State and Federal regulations to protect this species from overcollecting and damage from off-road vehicle use. Regulations should also be used to protect xeric vegetative communities where D. pulchellus lives. - Develop an ex situ collection. Ex situ collections are important for preserving genetic diversity, preventing extirpation, and determining ecological characteristics and habitat management needs of species. These collections will be instrumental in the recovery of D. pulchellus. Since longterm seed storage seems impossible for this species, cultivated populations are very important. Although D. pulchellus is not easily grown from cuttings, young plants should be kept for study and reintroduction material. - Augment natural populations of D. pulchellus. (USFWS, 1999)

- 3. Conduct research on life history characteristics of D. pulchellus. - Conduct research to determine demographic information, such as numbers of sites and populations, numbers of individuals in a population, recruitment, dispersal, growth, survival, and mortality. Observations of the relation of flowering to fire, pollination, seed production, and seedling biology will help to guide reintroduction efforts. - Once demographic data are known, conduct population viability and risk assessment analysis to determine the numbers of plants, sites, subpopulations/populations, and spatial distribution needed to ensure persistence of the species. - Conduct research to assess management requirements of D. pulchellus. Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring information will provide factors contributing to any declines at each site. Monitoring of populations should be in reference to various habitat management practices. Site-specific management guidelines should be provided to land managers and close coordination among land managers is essential to develop adaptive management techniques. - Assess feasibility of relocating D. pulchellus. Removing plants threatened with destruction may be the only conservation strategy available in some situations. Information on transplant techniques and plant survival are needed to assess whether transplanting should be pursued. (USFWS, 1999)
- 4. Monitor existing populations of D. pulchellus. - Develop monitoring protocol to assess population trends for D. pulchellus. - Develop a quantitative description of the population structure of D. pulchellus. This description will provide a baseline for monitoring population dynamics in response to natural environmental changes and management treatments. Data recorded should include morphology, survivorship, mortality, and reproduction for individual plants. Data about each plant’s microsite (vegetation cover, litter depth, substrate, and closest neighbors) may prove helpful in future management. - Monitor reintroduced plants. Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole. Compare adult survival, seed production, germination rates, seed survival, seedling survival, and growth rates between transplanted plants and natural plants. Where monitoring indicates that the introduction has been unsuccessful, reevaluate protocol and methodology. (USFWS, 1999)
- 5. Provide public information about D. pulchellus. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and

horticultural uses of endangered species provide little benefit to species, since the recovery of D. pulchellus and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

- 6. Establish delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Urbanization, fire suppression, and agricultural land uses have decreased the available habitat. - Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. - Continue habitat-level research projects. Study the response of D. pulchellus to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. - Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, etc., on the habitats where D. pulchellus occurs. - Provide public information about pine flatwood vegetative communities and their unique biota. Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about pine flatwood plant communities to the public. The State’s system of biological preserves depends for its funding and future success on a broad base of public understanding and support. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, the Florida Park Service, the Florida Native Plant Society and local garden clubs will play crucial roles in increasing public appreciation of pine flatwood plant communities and D. pulchellus. (USFWS, 1999)
- Management: • Continue management actions to include removal of hogs, debris, and exotic plants. Depending upon site, management efforts may include: licensed hunting or trapping of hogs, careful application of herbicides, controlling public access, and reintroduction of prescribed fire into the ecosystem. • Restore habitat in potential areas where plants could occur but are not currently reported, and provide follow-up surveys post-disturbance to determine if natural occurrences are present. • Identify additional reintroduction sites and establish reintroduced populations; augmentations should also be implemented. • Focus conservation efforts on marginal and small occurrences to preserve the genetic diversity of the species. (USFWS, 2009)
- Research: • Conduct research on the response of beautiful pawpaw to fire and fire prescriptions necessary to benefit the species. • Monitor burned and mowed sites to assess which technique is most beneficial to pawpaw reproduction and survival. • Continue research on the biology, ecology, genetics, and management needs of the species. • Conduct demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages. • Conduct genetic characterizations on occurrences, and apply this knowledge to future introductions and augmentations. • Continue to evaluate insect pollinators associated with the species over the long-term, and evaluate impacts to pollinators from aerial mosquito spraying. • Conduct seed germination studies and make efforts to develop additional outplanting techniques. • Continue propagation efforts and establish techniques for long-term germplasm storage; make sure all occurrences are represented in the Center for Plant Conservation's National Collection of Endangered Plants. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and

temperature rise. (USFWS, 2009)

- Surveys: • Continue to survey potential habitat and pursue conservation agreements, implement management recommendations, and/or acquire land and investigate incentives to encourage land managers to manage pine flatwoods for ecosystem health and listed species. • Conduct additional surveys for beautiful pawpaw on all known (particularly Estero Bay Preserve State Park, Pine Island Flatwoods Preserve, and the newly acquired Babcock Ranch) and potentially suitable sites in the three counties of occurrence; provide updated information to FNAI for consistent tracking. • Continue monitoring both reintroduced and natural occurrences. (USFWS, 2009)
- Other: • Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities x Continue removal of hogs and invasive plants species around beautiful pawpaw populations. Depending upon site, management efforts may include licensed hunting or trapping of hogs and careful application of herbicides to invasive plants. x Continue applying prescribed fire and reintroduce fire to habitats where this species occurs. Use careful mowing with minimal ground disturbance where burning is not possible or in combination with burning as a mechanical treatment to open up habitat and make the vegetation structure more suitable for beautiful pawpaw growth. x Restore habitat in potential areas where plants could occur but are not currently reported and provide follow-up surveys post-disturbance to determine if natural populations are present. x Identify additional (re)introduction sites, donor sites, and if needed, rescue sites (private lands slated for development) and establish reintroduced populations; augmentations should also be implemented where small, non-viable populations occur. x Focus conservation efforts on marginal and small populations to preserve the genetic diversity of the species. Monitoring/Research Activities x Continue to survey potential habitat all counties of occurrence and in corridor counties. x Conduct surveys of previously documented populations on private lands with a focus on those that have not been visited in over 20 years, occur on larger tracts, and/or are adjacent to existing conservation lands. x Conduct research on the response of beautiful pawpaw to fire and fire prescriptions necessary to benefit the species. x Monitor burned and mowed sites more closely to assess which technique is most beneficial to pawpaw reproduction and survival. x Determine long-term effects of using careful roller-chopping as a mechanical treatment on population viability x Conduct demographic studies to determine the age class structure and long-term viability of populations, especially in areas with active recruitment, and determine critical life stages. x Develop and carry out a monitoring protocol for reintroduced/augmented populations to better characterize long-term survival of individuals and population viability. x Conduct further genetic research to determine the level of genetic diversity that remains and is protected and apply this knowledge to future introductions and augmentations. Also, conduct further research to determine the level of hybridization with D. rugelii (Rugel's pawpaw) and A. pygmaea (dwarf pawpaw) in populations not yet assessed and the level of hybridization with A. reticulata. Collect voucher specimens of known hybrids to document their morphological characters. x Continue to identify and evaluate insect pollinators associated with the species with a focus on conducting pollinator surveys at night when likely but undocumented insect visitors may be active. x Investigate potential seed dispersers and their effectiveness. x Conduct additional seed germination trials and make efforts to develop additional outplanting techniques. x Continue propagation efforts and make sure all populations are represented in the Center for Plant Conservation's National Collection of Endangered Plants. x Support continued work and research into ex situ cryopreservation methods to preserve cell lines of this species. x Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. Outreach Activities x Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. x Actively engage and encourage private landowners to manage pine flatwoods for ecosystem health and listed species. x Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2021)

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# SPECIES ACCOUNT: *Deeringothamnus rugelii* (Rugel's pawpaw)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/27/1986; Southeast Region (R4)

**Physical Description**

A low, sparingly branched, scented shrub that grows from a stout taproot, rarely to 0.5 m tall. Leaves are alternate, erect, 1-7 cm long, oblong to oval in shape. Stems are arching or occasionally erect, seldom branched. Flowers are solitary in leaf axils with 9 yellow petals (NatureServe, 2015).

**Taxonomy**

Kartesz (1999) treats Deeringothamnus pulchellus and D. rugelii as distinct taxa. Ward (2001) treats D. pulchellus as a variety of D. rugelii (Novon 11(3): 360-365) (NatureServe, 2015).

**Historical Range**

D. rugelii is endemic to a small area of Volusia county (USFWS, 2018).

**Current Range**

D. rugelii is known to occur at Deep Creek Preserve, Longleaf Pine Preserve, Tiger Bay State Forest, Port Orange City Forest, Wiregrass Prairie Preserve, and Lake Monroe Conservation Area, which are all in Volusia County, FL (USFWS, 2018).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 - 2 years (above ground) (USFWS, 1988)

**Breeding Season**

Adult: Germinates in spring (USFWS, 2018)

**Key Resources Needed for Breeding**

Adult: Fire (USFWS, 1988)

**Reproduction Narrative**

Adult: Blooms in the spring (Small 1933) (NatureServe, 2015). The above-ground stems bear seed and fruit the first year after a fire, and appear to live for only one or two years (Wunderlin et al. 1981) (USFWS, 1988).

**Habitat Type**

Adult: Flatwoods with an open canopy of slash pine (P. elliottii var densa) or longleaf pine. This species also occurs in pastures and in road and utility rights-of-way (USFWS, 2018).

**Habitat Vegetation or Surface Water Classification**

Adult: Groundcover assemblages within the flatwood communities include wiregrass (Aristida stricta) and a diverse array of other herbaceous plants (USFWS, 2018).

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (NatureServe, 2015)

**Environmental Specificity**

Adult: High

**Habitat Narrative**

Adult: Rugel's pawpaw occurs in flatwoods with an open canopy of slash pine (P. elliottii var densa) or longleaf pine. This species also occurs in pastures and in road and utility rights-of-way. It is found in mesic and wet flatwood enviroments, though one occurrence is known to occur in disturbed conditions. Soils that support this species are often deep, fine textured, poorly drained sand or sandy peats (USFWS, 2018). Fires limit the growth of larger shrubs that would otherwise compete with this species (USFWS, 1998).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Stable (USFWS, 2018)

**Species Trends:**

Stable (USFWS, 2018)

**Number of Populations:**

22 Extant (USFWS, 2023)

**Population Size:**

2,142-4,538 (USFWS, 2018)

**Population Narrative:**

Rugel's pawpaw has only occurred in a small area of Volusia County in northeastern peninsular Florida. From the time of its initial discovery through 1998, 25 occurrences of D. rugelii had been located within Volusia County. In 1998, the number of plants reported from previous surveys among the known populations ranged from 2,142 to 4,538 individuals with 9 of the 25 occurrences including more than 100 plants. Many additional surveys were conducted since 1998 and as of 2017, there are 36 occurrences documented in Volusia County with 33 being natural occurrences. Eighteen occur on protected conservation lands and 15 occurrences on unprotected private lands or highway and utility rights-of-way. The introduced populations occur on two protected sites. When a separation distance between occurrences is used, 9 separate potential populations are evident. The species status is stable but range-wide surveys are needed to confirm presence on all sites and proper management of existing sites will provide long-term benefits to this species (USFWS, 2018). While the number and configuration of populations is unknown, currently, there are 42 known occurrence records (Table 1; Appendix A, Table A.1) with distribution occurring primarily between the Deland and Atlantic Coastal ridges in Volusia County, Florida. Of these occurrences, 22 are extant, 8 are extirpated, and the status of 12 are unknown. These occurrence records include Florida Natural Areas Inventory (FNAI) Element of Occurrence (EO) records, transplant sites, and additional sites identified through the Florida Native Plant Society (FNPS) Pawpaw Chapter's annual survey efforts. In 2021, 20 plants from the Bok Tower Gardens rescue and tissue culture collection were transplanted into a pre-selected site on the Longleaf Pine Preserve. Eighteen of these plants were sourced from tissue culture propagated plantlets and two were individuals rescued from the Defrates property (Edwards et al. 2021). As of 2023, no survival of transplanted individuals was recorded in this site (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat degradation and destruction (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat to this species is destruction and modification of habitat on private lands. Degradation of habitat resulting from a lack of adequate management on public and private lands remain a threat. Habitat loss and destruction from development is not a threat, degradation as a result of inadequate management is a concern. Additionally, elongated fire return frequencies and complete absence of periodic fire in some places has also led to habitat degradation (USFWS, 2018).

***Recovery***

**Reclassification Criteria:**
Ten (10) viable populations are established at secure sites (USFWS, 1988).

Recovery Priority Number: 2

**Delisting Criteria:**
Twenty (20) viable populations are established at secure sites (USFWS, 1988).

**Recovery Actions:**
- Conduct a range-wide survey of all existing populations and historic sites where populations formally existed that have not been developed. For all populations occurring on conservation lands; document current abundance, population trends, demographic trends, and habitat suitability. Conduct a Population Viability Analysis (PVA) to help determine a minimum viable population number (USFWS, 2018).
- When surveying plants note any associations with caterpillars and collect insects for proper identification in order to better understand the relationship between the organisms (USFWS, 2018)

- Support further research on the effects of prescribed burning and other management tools on D. rugelii, its life history needs, and microhabitat requirements (USFWS, 2018).
- Support further research into population genetics to better understand basic biology of the species, genetic variation within and among populations and across landscape, and whether hybridization is occurring with related and co-occurring species (USFWS, 2018).
- Support further research into microbiome and whether specific microorganisms area associated with this species, which may serve to inform future introduction sites (USFWS, 2018).
- Continue collaboration with conservation land managers to increase habitat management and suitability of occupied habitat (USFWS, 2018).
- Collect habitat management activity information from conservation land managers to increase habitat management and suitability of occupied habitat (USFWS, 2018).
- Actively engage private landowners and public non-conservation land owners (e.g. roadside rights-of-way) to protect and increase management efforts to benefit occupied habitat (USFWS, 2018).
- Continue transplantings from threatened sites (USFWS, 2018).
- Conduct reintroductions and possibly augmentations on publically owned conservation lands with suitable habitat and develop best approaches for conducting introductions to assist in meeting recovery goals (USFWS, 2018).
- Develop a monitoring protocol that indicates frequency and timing for future consistency and long-term trend analysis (USFWS, 2018).
- Support continued work and research into ex situ cryopreservation to preserve cell lines of this species (USFWS, 2018).
- Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing threats identified in the recovery plan, as well as update information on the species distribution and biology (USFWS, 2008).
- Support further research on: a. The effects of prescribed burning and other management tools on D. rugelii. Continue working with public land managers to increase management efforts to benefit D. rugelii on their sites. B. Additional life history needs. C. The most appropriate methodology to germinate seeds or tissue cultures, grow seedlings, and successfully out-plat seedlings to native habitat (USFWS, 2008).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2008).
- Complete a rangewide survey to find all sites known to be occupied by or have the potential to be occupied by D. rugelii and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2008).
- Consider reintroduction and monitoring of D. rugelii on additional publicly owned lands with suitable habitat. Reintroduction of D. rugelii could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1986). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Increase collaboration with conservation area land managers to improve habitat conditions of occupied sites through the application of prescribed fire. Implement mechanical vegetation management such as mowing and hand removal in areas where burning is not possible or in combination with burning to restore and maintain habitat conditions for Rugel's pawpaw. • Restore habitat on public and private lands in areas where plants could occur but have not been documented and implement post-restoration surveys to determine if natural populations are present. • Prioritize and implement rescue on sites with focus on sites identified for possible rescue. • Identify and prioritize additional (re)introduction sites and establish reintroduced populations. • Identify and prioritize occupied private lands that are good candidates for conservation acquisition and work with partners to acquire high priority parcels. Monitoring/Research Activities • Develop and conduct annual surveys in occupied secure sites to evaluate long-term population trends. • Conduct surveys in areas of previously documented occurrences focusing on sites with an unknown status. • Conduct research on the effects of growing vs. dormant season burning to determine if seasonality of prescribed fire significantly influences flowering and fruiting. • Conduct studies to determine the minimum viable population size required for a selfsustaining population. • Develop and implement survey and monitoring protocol for reintroduced/augmented populations to better determine long-term survival of individuals and population viability. • Conduct further research to determine species boundaries between Rugel's pawpaw and beautiful pawpaw. • Conduct studies to identify potential overlap in timing of flowering between dwarf pawpaw and Rugel's pawpaw to determine how this may relate to incidence of interspecific hybridization. • Conduct studies to identify and evaluate insect pollinators associated with the species. • Continue propagation efforts and ensure all populations are represented in the Center for Plant Conservation's National Collection of Endangered Plants gardens (e.g., Bok Tower Gardens). • Support continued work and research into ex situ cryopreservation methods to preserve cell lines of this species. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. Outreach Activities • Increase collaboration with conservation land managers to provide annual reporting on habitat management activities and relevant observations in occupied areas. • Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Actively engage and encourage private landowners to manage pine flatwoods for ecosystem health and listed species. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public (USFWS, 2023).

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# SPECIES ACCOUNT: *Deinandra increscens ssp. villosa* (Gaviota Tarplant)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/20/2000; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

Deinandra increscens ssp. villosa has pale to deep yellow disk and ray flowers. The foliage is variable gray-green and soft hairy. The plants generally range from 12 to 35 in (30 to 90 cm) tall with stems that generally branch near the base. The lower leaves are 2 to 3.4 in (5 to 8.6 cm) long. The inflorescence is typically rounded to flattopped with the flower heads in tight groups or paired. The peduncles are generally shorter than the involucres with mostly 13 ray flowers per head, but can vary between 8 and 15 ray flowers, and generally have 16 to 32 disk flowers per head (Baldwin 2009). Each flower head of Deinandra increscens ssp. villosa and other species in the family Asteraceae produce one-seeded fruits called achenes. (USFWS, 2011)

**Taxonomy**

Baldwin (2009) states "Deinandra increscens subsp. villosa differs from subsp. increscens in having more congested and, on average, shorter (generally < 45 cm tall) capitulescences, with phyllaries shorter than associated peduncles and peduncular bracts strongly overlapping the phyllaries, sometimes forming a distinct calyculus. Compared to D. increscens subsp. increscens, D. increscens subsp. villosa often has larger heads, which can reach the largest sizes in D. increscens, with up to 14 (–15) rays and up to 32 discs per head, but head size overlaps strongly with that of D. increscens subsp. increscens. Deinandra increscens subsp. villosa is known only from Santa Barbara County, mostly from the vicinity of Point Conception to Gaviota and north to the northern slopes of the western Santa Ynez Mountains", with outlying populations at Point Arguello and a northern outlier at Lion's Head (near Point Sal) (Baldwin 2009; Baldwin, pers. comm.2010a, pers. comm. 2010b; Elvin 2010b). (USFWS, 2011)

**Historical Range**

Historically, Deinandra increscens ssp. villosa was originally known only from the immediate vicinity of the unincorporated town of Gaviota, with plants occurring up to several kilometers in either direction along the immediate coast. (USFWS, 2011)

**Current Range**

Currently, it has a highly localized distribution in western Santa Barbara County, California with seven main populations that range from the vicinity of Point Sal in the north to Gaviota in the south. (USFWS, 2011)

**Critical Habitat Designated**

Yes; 11/7/2002.

**Legal Description**

On November 7, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Deinandra increscens ssp. villosa (Gaviota Tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in

California (67 FR 67968-68001).

**Critical Habitat Designation**

The critical habitat designation for Deinandra increscens ssp. villosa includes three CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 9,709 acres (67 FR 67968-68001).

Sudden Peak Unit: The Sudden Peak Unit consists of a 5- km (3-mi) stretch of ridgeline in the western portion of the Santa Ynez Mountains west of Sudden Peak, and generally includes grasslands above the 215-meter (700-foot) contour line. This unit is 320 ha (791 ac) and is comprised entirely of privately owned lands. Vandenberg Air Force Base holds an easement on a portion of these private lands. This unit includes two populations of Deinandra increscens ssp. villosa that comprised over 1,000 individuals in 1998. This unit is known to support populations away from the immediate coast and is at higher elevation than any other known D. increscens ssp. villosa location (425 m (1400 ft)). As a result, the populations in this unit experience more extreme seasonal temperatures and a lack of summer fog than most other populations which occur directly on the coast.

Santa Ynez Unit: The Santa Ynez Unit consists of a 9.7-km (6-mi) stretch of ridgeline of the Santa Ynez Mountains, ranging from Canada de las Agujas east to Canada del Agua Caliente. This unit of 433 ha (1,070 ac) is comprised entirely of privately owned lands. Deinandra increscens ssp. villosa occurs at 305 m (1,000 ft) in this unit, on the sandy mountain ridgelines. This unit supports two known populations of D. increscens ssp. villosa that comprised approximately 400 individuals in 1998. The terrain here differs from most other known locations in that it is characterized primarily by slopes that intergrade with flatter areas, rather than a flat marine terrace.

Conception-Gaviota Unit The Conception-Gaviota Unit consists of a 51.5-km (23-mi) long stretch of habitat along the coast from Point Conception, east to Gaviota, and encompasses 3,176 ha (7,848 ac). At its widest point, this unit extends inland approximately 3.2 km (2 mi). This unit is comprised almost entirely of privately owned lands (98 percent). This unit also consists of State lands at Gaviota State Beach and lands in the process of being transferred to CDFG for the Gaviota Tarplant Reserve (2 percent). This unit is particularly important because it supports most of the known populations of Deinandra increscens ssp. villosa that occur along the immediate coast. This includes the Gaviota population which was once extensive but is currently in decline, two small patches discovered in 1998 between Gaviota and Point Conception, and an extensive population discovered in 2000 that ranges from Government Point to the area near Jalama Beach County Park. Given these recent observations and the proximity to existing populations, we believe that there may be additional unsurveyed areas within the unit that may support D. increscens ssp. villosa. The populations here occur on a flat marine terrace along the immediate coast and likely experience summer fog and a mild maritime climate.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Deinandra increscens ssp. villosa critical habitat consists of two components (67 FR 67968-68001):

(i) Sandy soils associated with coastal terraces adjacent to the coast or uplifted marine sediments at interior sites up to 5.6 km (3.5 mi) inland from the coast, and

(ii) Plant communities that support associated species, including needlegrass grassland and coastal sage scrub communities, particularly where the following associated species are found: Needlegrass species (Nassella spp.), California sagebrush (Artemisia californica), coyote bush (Baccharis pilularis), sawtooth golden bush (Hazardia squarrosa), and California buckwheat (Eriogonum fasciculatum).

**Special Management Considerations or Protections**

Special management considerations or protections may be needed to maintain the primary constituent elements for the two taxa within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites, and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two taxa. We have outlined below the kinds of special management and protection that these two taxa would most likely require. These recommendations for management and protection are general in nature. Specific management actions should be developed according to local site conditions. Not all of these will apply to each plant taxon equally. (1) Existing soil conditions should be protected by avoiding activities that cause the erosion or compaction of soils. Maintaining an intact soil profile may be necessary to maintain edaphic features such as a horizon of permeable sandy soils on the surface layer. For example, Deinandra increscens ssp. villosa is thought to be restricted to acidic, fine sandy loams with a subsurface clay layer that may act as a reservoir of soil moisture. (2) Existing hydrologic conditions should be protected by avoiding activities that cause a change in surface or subsurface water flows upon which the plant taxa depend. For example, development of areas adjacent to a population may result in an increase in runoff and surface water flow. This alteration may affect the soil moisture content to which the local population has adapted. (3) In all plant communities where these taxa occur, invasive, non-native species, such as harding grass (Phalaris aquaticus), veldt grass (Ehrharta calycina), and iceplant (Carpobrotus edulis), should be actively managed. Invasive non-natives pose a serious threat to the survival of Deinandra increscens ssp. villosa and Eriodictyon capitatum and remaining habitat of the taxa. For example, accumulated dead leaves and stems (thatch) from nonnative grass species that dominate the habitat effectively prevent the establishment of D. increscens ssp. villosa at a site. Iceplant is known to invade native maritime chaparral vegetation occupied by Eriodictyon capitatum. Once non-native grasses and other invasive plants (e.g., iceplant) have become established, they cannot be removed without great expenditure of time and effort. (4) The composition of the native plant and animal communities associated with the taxa must be maintained. Native plant diversity may limit the ability of aggressive non-native plants to invade a population (Dukes 2002). In addition, a decline in biodiversity may increase the potential impact of invasive plants on a community (e.g., suppression of growth). Recent research suggests that grassland communities with fewer species may be more likely to decline as a consequence of invasion (Dukes 2001). In addition, native plant diversity may increase pollinator activity and therefore enhance the conservation of a plant species. Biologists have suggested that a plant population may persist as long as it occurs within an area of a diversity of plant species that are attractive to pollinators (Kwak 1988). Habitat fragmentation and isolation of species-rich grasslands, with intervening areas of no or low diversity of native plants, has been found to negatively affect plant-pollinator interactions (Stephann-Dewenter and Tscharntke 1999). (5) The local distribution of plant communities should be managed to provide for the physical requirements of the taxa (e.g., space for establishment). For some grassland areas, it may be important to maintain openings within or between coastal scrub communities that might otherwise encroach upon grassland patches that support Deinandra increscens ssp. villosa. (6) Certain areas where these taxa occur may need fencing to protect them from accidental or intentional trampling by humans and livestock. Portions of three of the five units are currently used by livestock

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated.

**Lifespan**

Adult: 1 year (USFWS, 2011)

**Breeding Season**

Adult: June to September (NatureServe, 2015)

**Other Reproductive Information**

Adult: SBBG completed two new studies focused on Gaviota tarplant pollinators and other factors associated with pollination of the species at the Sudden Peak/Tranquillon Mountain population/occurrence 12 (Figure 1). In the first study, Knapp et al. (2021) found that Gaviota tarplant attracts a diversity of insect flower visitors in five orders: Coleoptera (beetles), Diptera (flies), Hemiptera (true bugs), Hymenoptera (sawflies, wasps, bees, and ants), and Lepidoptera (butterflies and moths). Of a total of 110 flower visitors observed during the study, 99 of them were using Gaviota tarplant and only 11 were using other co-occurring species. Therefore, Gaviota tarplant may be a magnet species within areas it occupies, such that it increases pollination of other less attractive, co-occurring species and is the main agent drawing pollinators to occupied areas. They also found that percent cover of Gaviota tarplant and sampling month were the most important factors affecting the model for flower visitor richness and abundance. Maximum pollinator activity occurred during the months of July and August, which corresponded to the peak robustness of Gaviota tarplant observed through the month of August. Other important variables, including distance to nearest wind turbine (because the study plots are located within a wind-energy construction site), number of Gaviota tarplant flowers present, richness of flowering species present, and cover of blooming, non-Gaviota tarplant species also contributed to the best fit model. But none of these other variables were statistically significant (USFWS, 2022)

**Reproduction Narrative**

Adult: Deinandra increscens ssp. villosa (Gaviota tarplant) is a self-sterile annual plant in the sunflower family (Asteraceae) (Tanowitz 1982; Keil 1993; B. Baldwin, University of California, Berkeley, Jepson Herbarium, in litt. 2001; Baldwin 2010). Each flower head of Deinandra increscens ssp. villosa and other species in the family Asteraceae produce one-seeded fruits called achenes.

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grasslands intergrading with coastal sage scrub (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Soil pH of 5.0 or lower, prefers marine terraces and uplifted marine sediments ranging from 150 to 1,000 feet (46 to 305 m) (USFWS, 2011; NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist

**Dependency on Other Individuals or Species for Habitat**

Adult: Deinandra increscens ssp. villosa is associated with grasslands comprised of native Nassella spp. (needlegrass), nonnative species such as Avena spp. (wild oats) and Bromus diandrus (ripgut brome), and other herbs and grasses. The grasslands throughout the range of the species are interspersed with coastal sage scrub generally dominated by Artemisia californica (California sagebrush), Baccharis pilularis (coyote brush), Hazardia squarrosa (sawtooth golden bush), and Eriogonum fasciculatum (California buckwheat) (California Natural Diversity Database (CNDDB) 2010). (USFWS, 2011)

**Habitat Narrative**

Adult: Gaviota tarplant requires grassland habitats. Occupied areas often intergrade with coastal sage scrub communities and are dominated by nonnative, Mediterranean annual grasses such as wild oat (Avena spp.), bromes (Bromus spp.), false brome (Brachypodium distachyon), and nonnative forbs like storksbill (Erodium spp.). Native grasses and forbs can also co-occur with Gaviota tarplant but are typically less dominant. Shrubs are largely absent in stands occupied by the species, although shrubs may occur in intergrade zones and other successional areas, like sawtooth goldenbush (Hazardia squarrosa), California buckwheat (Eriogonum fasciculatum), and coyote brush (Baccharis pilularis). Areas that provide suitable grassland habitats for the species include marine terraces, coastal bluffs, active and inactive cattle ranches, undeveloped plains and prairie areas, and open fields (USFWS, 2022).

***Dispersal/Migration***

**Dispersal**

Adult: High (USFWS, 2011)

**Dispersal/Migration Narrative**

Adult: Achenes of Deinandra spp. are most likely dispersed by adhesion of the sticky bracts clasping the ray achenes to animal fur or feathers (Baldwin, in litt. 2001). (USFWS, 2011)

***Population Information and Trends***

**Population Trends:**

Unknown

**Number of Populations:**

27 (USFWS, 2022)

**Population Size:**

>1,000,000 at one site (USFWS, 2022)

**Population Narrative:**

Currently, Deinandra increscens ssp. villosa has a total of 26 known occurrences grouped among 7 populations ranging from the coastal terraces on the bluffs at Lion’s Head near Point Sal to the mountains of the Western Transverse Ranges, to the coastal terraces on the bluffs at Point Conception and Gaviota (Service 2000, 2002, CNDDB 2010, CCH 2010; Baldwin 2009, 2010; Elvin 2010a, 2010b). The number of standing Deinandra increscens ssp. villosa plants has been shown to vary considerably within any given occurrence from year to year. (USFWS, 2011). Gaviota tarplant is now known from a total of 27 occurrences all within southwestern Santa Barbara County (Figure 1). Most of the occurrences are distributed across the same seven core populations identified in our 2011, 5-year review (Service 2011, pg. 6). From Gaviota, traveling north these include: 1. Gaviota Coast; 2. Hollister Ranch Coast; 3. Hollister Ranch/Santa Ynez Mountains; 4. Point Conception/Dangermond; 5. Sudden Peak/Tranquillon Mountain; 6. Point Argeullo; and 7. Point Sal/Lions Head. There are two new Gaviota tarplant occurrences, numbers 13 and 14 that are recently discovered colonies mapped along the coast, in areas north of Jalama Beach, predominantly on VSFB (VSFB 2022, pers comm). Portions of occurrence 14 were first mapped on VSFB in 2015 (ManTech SRS Technologies 2016, pg. 20; ManTech SRS Technologies 2020, pg. 12). There is also a historical herbarium record within occurrence 14 collected in 1928 (CCH2 2022, website). The rest of the colonies within occurrence 14, and all of occurrence 13, were mapped on VSFB in 2019 (ManTech SRS Technologies 2020, pg. 12 and 41). Therefore, we now recognize a new eighth population of Gaviota tarplant that we are referring to as Jalama Beach (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Degradation and loss of habitat due to agriculture and urban development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the time of listing, threats to Deinandra increscens ssp. villosa and its habitat by degradation and loss of habitat have increased due to agriculture and urban development (Service 2000, CNDDB 2010). Populations on Hollister Ranch, along the coast, and in the Santa Ynez Mountains are affected by trampling from cattle and horses, discing for agricultural practices, and residential development (CNDDB 2010; M. Meyer, California Department of Fish and Game (CDFG), in litt. 2010a). For instance, CDFG issued an incidental take permit (ITP) for a single family house to be located within an area known to be occupied by D. increscens ssp. villosa (CDFG ITP permit 2018-2004-042-05) in 2004. Cattle and horses continue to graze in D. increscens ssp. villosa habitat between Gaviota State Park and Jalama Beach County Park (CNDDB 2010). Cattle grazing in some areas occupied by D. increscens ssp. villosa appears to have facilitated the displacement of D. increscens ssp. villosa and favored the dominance of D. fasciculata, (fascicled tarplant) a common native tarplant in other parts of southern California (Rindlaub, in litt. 1998). (USFWS, 2011)

**Stressor:** Invasion of additional nonnative species of eucalyptus (USFWS, 2011)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Nonnative Eucalyptus trees were planted in the Gaviota area on adjacent private lands and along Highway 101 as visual screens, windbreaks, and landscaping during the early 1900s and have continued to spread since then. Several species of Eucalyptus are present on various private and public properties in the area. Some species are expanding and increasingly overtaking coastal grasslands and scrub-lands (e.g., Eucalyptus conferuminata, E. globulus) (Meyer, in litt. 2010a; Ritter, pers. comm. 2010; Ritter, in litt. 2011). (USFWS, 2011)

**Stressor:** Loss of habitat and indirect effects from wind energy development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Lompoc Wind Energy Project is a commercial wind energy facility proposed to be constructed and operated on approximately 2,950 acres (1,194 ha) in the Sudden Peak and Tranquillion Mountain area (CH2M Hill 2007). The project is planned to include the following components: 60 to 80 wind turbine generators, new access roads and road improvements, a communication system, meteorological towers, an operations and maintenance facility, onsite electrical collection and distribution lines, an onsite project substation, a new 7.85-mile (12.6km), 115-kilovolt Pacific Gas and Electric (PG&E) power line to the Lompoc area to interconnect with the PG&E electric grid, and upgrades to existing PG&E facilities in the area. Deinandra increscens ssp. villosa occurs throughout the central and western portions of the 2,950-acre (1,194-ha) project site and all 791 acres (320 ha) of the Sudden Peak Unit of critical habitat for D. increscens ssp. villosa occur within the project site (CH2M Hill 2007, Service 2002). This proposed project would likely have direct and indirect effects to occupied D. increscens ssp. villosa habitat. Effects from this project (direct and indirect) are estimated to include loss or modification of habitat; changes in hydrology; temporary or permanent loss of individuals; changes in vegetation; and an increase in nonnative or invasive species, night-lighting, dust, noise, and vehicle emissions (CH2M Hill 2007). The effects of competition with nonnative species is most problematic immediately adjacent to habitat that has been isolated or fragmented by development (Alberts et al. 1993). The development of wind energy projects in areas occupied by D. increscens ssp. villosa may also affect individuals or seed banks for this species and are further discussed in Factor E below. There are additional leases for wind energy development within the range of D. increscens ssp. villosa (Meyer, in litt. 2011), at the north end of the range near Point Sal and at the south end of the range near Point Conception. (USFWS, 2011)

**Stressor:** Sea level rise due to climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sea level rise, as a result of global climate change, has the potential to alter and diminish the habitat of Deinandra increscens ssp. villosa because of its proximity to the coastline. At the time of listing D. increscens ssp. villosa, we did not discuss the potential effects of climate change on its long-term persistence (Service 2000). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The specific manner in which climate change could affect D. increscens ssp. villosa is unknown at this time due to the general nature of these predictions.

Because five of the seven populations of D. increscens ssp. villosa occurrences are on coastal terraces, erosion of these areas and corresponding loss or decreased quality of habitat could adversely affect these populations by causing habitat conversion within and adjacent to occupied habitat areas for this species. Climate change and sea level rise may also affect individuals or seed banks for this species. (USFWS, 2011)

**Stressor:** Development and alteration of habitat from mission operations at VAFB (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Facility maintenance and development for military and private commercial purposes planned at VAFB may result in loss and alteration of habitat occupied by Deinandra increscens ssp. villosa (U.S. Air Force 2008). Deinandra increscens ssp. villosa is known to occur in and around launch sites on VAFB (CNDDB 2010, Elvin 2010b). The U.S. Air Force conducts vegetation maintenance activities around launch facilities at VAFB to reduce the chance of fires. Additionally, the potential for deposition of exhaust products from launch vehicles could adversely affect D. increscens ssp. villosa and its habitat. Mission operations (e.g., antiterrorism operations, space launches), infrastructure support activities (e.g., road and utility maintenance), and environmental management programs (e.g., grazing and invasive species removal) may affect D. increscens ssp. villosa (U.S. Air Force 2008). Missile launch operations, such as adjacent to Space Launch Complex-6, could adversely affect habitats surrounding launch facilities. In 1993, a missile was destroyed shortly after launching at VAFB, and a series of brush fires caused by burning rocket fuel burned more than 400 acres (162 ha). Large fragments of metal blasted downward toward the ground caused physical damage to the habitat on base around the launch site (Wallace 1993). In September 1997, a 500-acre (200-ha) fire and a 1,500-acre (600-ha) fire burned near occupied habitat of Eriodictyon capitatum (Los Angeles Times 1997a). Fire containment lines constructed by bulldozers in the vicinity of the species were observed after the fire (J. Watkins, U.S. Fish and Wildlife Service, pers. comm. 1997). On November 1, 1997, a 1,225-acre (495-ha) fire that was accidentally set by an explosives disposal team at VAFB was partially contained by back-burning (Los Angeles Times 1997b). Mission operations may also have direct effects to individual D. increscens ssp. villosa plants and the seed bank and are further discussed in Factor E below. While mission operations at VAFB may have some adverse effects to D. increscens ssp. villosa and its habitat, the U.S. Air Force's mission at VAFB is expected to have long-term benefits to D. increscens ssp. villosa and its habitat because, in order to accomplish its mission at VAFB, the U.S. Air Force needs to maintain extensive tracts of undeveloped and encroachment-free property. These extensive tracts of undeveloped and encroachment-free property will likely allow D. increscens ssp. villosa to persist. (USFWS, 2011)

**Stressor:** Cattle grazing (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service also stated that cattle grazing has occurred within the habitat of D. increscens ssp. villosa and that low levels of grazing may enhance the opportunities for it to propagate successfully, as it may serve to reduce competition from nonnative species. However, some evidence indicates that heavy grazing has affected individuals of D. increscens ssp. villosa by reducing their stature and the number of seeds that can be produced. Populations on Hollister Ranch, along the coast, and in the Santa Ynez Mountains are affected by cattle and

horse grazing (CNDDB 2010; Meyer, in litt. 2010a). VAFB leases grazing allotments that overlap with portions of all three populations on the base, the allotments are managed under a rest and rotation system that minimizes adverse effects and maximizes the reproductive success of populations that are grazed (U.S. Air Force 2008). An analysis of these threats is contained in the final rule and appears to remain currently valid. (USFWS, 2011)

**Stressor:** Flower beetle (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service stated that approximately 50 percent of the disk and ray achenes of D. increscens ssp. villosa had been observed to be infested by an unidentified flower beetle (Rindlaub, in litt. 1998). (USFWS, 2011)

**Stressor:** Genetics issues as affected by small population size (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Most species in the genus Deinandra (including D. increscens ssp. villosa specifically) are self-incompatible and cannot produce viable seeds without cross pollinating within their respective taxa (Baldwin, in litt. 2001). Evolutionary processes such as mutation, natural selection, genetic migration, and random genetic drift are known to adversely affect small populations (Barrett and Kohn 1991). Adverse effects from these evolutionary processes on self-incompatible species such as D. increscens ssp. villosa are magnified by its self-incompatibility (Keck 1959; Tanowitz 1982; Baldwin, in litt. 2001). Maintaining gene flow among the populations is essential to counter the adverse effects from the evolutionary forces mentioned above and to ensure the long-term survival and conservation of this species. Both theoretical and empirical evidence indicates that smaller populations (those also possessing lower genetic variation) tend to have higher mortality rates and reduced fecundity, which leads to demographic fluctuations (Lande 1988, Les et al. 1991, DeMauro 1993, Heywood 1993, Lacy 1997, Frankham et al. 2002). At the extreme, very small populations suffer from inbreeding depression and the adverse effects of genetic drift (Barrett and Kohn 1991, Les et al. 1991). In plant species exhibiting sporophytic self-incompatibility, such as D. increscens ssp. villosa, the potential for adverse effects from inbreeding and genetic drift are greater than in species with gametophytic self-incompatibility (Baldwin, in litt. 2001). A reduction in population size, due to demographic or environmental stochasticity or long-term fragmentation of populations, could reduce the pool of S alleles, thereby reducing successful cross-pollination and reproduction (Les et al. 1991, DeMauro 1993). (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is clear that an increase in the rate of sea level rise has been predicted for the coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). In particular, beaches and coastal bluffs along the coast will be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 with an estimated rise

in sea level in Santa Barbara County at 5.28 feet (1.61 m) (CCC 2001, Heberger et al. 2009). Because many D. increscens subsp. villosa occurrences are on the terraces on coastal bluffs, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks in five of the seven populations of this species. See Factor A for additional discussions regarding climate change in relation to this species. (USFWS, 2011)

**Stressor:** Emergency response activities (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Many Deinandra increscens ssp. villosa populations occur on coastal bluffs or open areas in the Santa Ynez Mountains that are associated with grasslands and sparse coastal sage scrub. Many of the known populations of this species grow in and adjacent to large open areas that generally have little vegetation and a flat or level geography that also has easy access from paved roads. These features are attractive to and preferred by emergency response organizations for use as staging areas and command posts during emergency response situations such as wildfires or other law enforcement actions. Establishing staging areas and or command posts quickly and close to a developing situation is important and the agencies may not have the ability to check resource databases (e.g., CNDDB) before setting up these posts to conduct their essential operations. Establishing a staging area or command post on D. increscens subsp. villosa plants would result in the crushing of these plants and seeds. (USFWS, 2011)

**Stressor:** Nonnative, Invasive Weeds (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative, invasive weeds compete directly with native species for resources and degrade habitat quality. Further, buildup of thatch from nonnative, invasive weeds can inhibit and arrest germination of natives and suppress their seedbanks. Strauss, and other future development projects, will have ongoing operational and maintenance components that have potential to continue to adversely affect the species and its habitat via introduction and spread of nonnative, invasive weeds. Development increases habitat fragmentation, which increases edge effects around occupied areas, that results in expansion and spread of nonnative, invasive weeds and increased fire risk. In turn, shifts in the plant species community composition can adversely affect pollinators, and increased fire frequency typically results in increased spread and expansion of nonnative, invasive weeds (USFWS, 2022).

**Stressor:** Climate Change Effects (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Langridge et al. (2018) provides a comprehensive assessment of the climate changes that will affect California’s Central Coast bioregion, which includes Santa Barbara County. Anticipated changes consist of increased maximum and minimum temperatures, slightly increased precipitation with substantially increased variability, increased locally extreme rainfall events, accelerated sea level rise, and increased drought (Langridge et al. 2018, pg. 6). The tolerance of Gaviota tarplant to these climate changes is unknown. We provide specific data for expected changes in precipitation and increased maximum and minimum temperatures at four

key locations throughout the species range (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**

- Recovery actions are not available.
- Develop a recovery outline and recovery plan for Deinandra increscens ssp. villosa. (USFWS, 2011)
- Work with the U.S. Air Force at VAFB to implement site-specific management activities (e.g., refining grazing regimes, eradicating nonnative species) to maintain suitable habitat on the base for this species. (USFWS, 2011)
- Work with partners to manage threats to this species throughout its range, such as increasing efforts to remove nonnative species and planning the timing of activities that occur within and adjacent to occupied habitat. (USFWS, 2011)
- Develop conservation and land use management plans or habitat conservation plans with the County of Santa Barbara, the agricultural community, developers, local landowners and stakeholders to facilitate this species occurring and migrating throughout its historical range. (USFWS, 2011)
- Conduct updated surveys throughout the range of the species. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access (if possible) to all mapped Gaviota tarplant occurrences to conduct comprehensive surveys of the status of the species and threats at these locations. Include estimates of numbers of individuals present, global positioning system (GPS) mapping of occupied spatial area, co-occurring and co-dominant vegetation, presence of natives versus nonnative species, timing of phenology, and observations of potential insect pollinators. Update information in resource agency databases (CNDDB) to ensure that these data remain accurate and current. 2. Create a standardized annual, quantitative Gaviota tarplant monitoring protocol that includes the parameters outlined in item 1 above. Organize occurrence landowners and other stakeholders to commit to conducting annual monitoring for a minimum of five consecutive years, in support of the next 5-year review. 3. Conduct experimental research on strategic, applied grazing as a management tool for Gaviota tarplant recovery and nonnative, invasive weed controls. 4. Implement management activities to ameliorate threats at each occurrence, including vegetation management such as trimming and removal, applied-strategic grazing, invasive weed abatement, and erosion controls. 5. Conduct research across the species range to improve and refine our understanding of taxonomy to achieve a consensus on morphological identification of the species. Data from this assessment will ideally resolve taxonomic ambiguities to inform rapid visual identification of Gaviota tarplant in the field. This work will also help us better understand the natural spectrum of variant morphologies associated with normal phenotypic plasticity, likely resulting from different ecological conditions (such as shallow soils and interior versus coastal populations). 6. Continue conducting genetics research to better understand

and delineate Gaviota tarplant from grassland tarweed using modern molecular techniques intended for these types of resolutions. This will improve our knowledge of how these two subspecies are separated genetically and help reach a standard for how genetic data should be used to define and interpret the listed entity. 7. Continue making accessions for conservation seed banking throughout the species range, so that all populations are represented in the collections. 8. Pursue opportunities to work with landowners and other stakeholders to augment extirpated and/or declining Gaviota tarplant occurrences and locate and prioritize other areas where introduction of the species via outplanting for recovery could be feasible. New introduction projects will focus on re-establishing and maintaining connectivity of other extant populations throughout the species range (USFWS, 2022).

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# SPECIES ACCOUNT: *Delphinium bakeri* (Baker's larkspur)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/25/2000; Pacific Southwest Region (R8)

**Physical Description**

A perennial dry season-dormant herb that grows from a thickened, tuber-like, fleshy cluster of roots, to a height of 26 inches (in) (65 centimeters (cm)). The leaves are five-lobed, occur primarily along the upper third of the stem, and are green at the time of flowering. Another distinctive feature of the leaves is that they have a whitish area in the center. The flowers are irregularly shaped. The five sepals (outermost whorl or set of floral parts) are conspicuous, bright dark blue or purplish, with the rear sepal elongated into a spur. The inconspicuous petals occur in two pairs. The lower pair is blue-purple; the upper pair is white. Seeds are produced in several dry, many-seeded fruits, called follicles, which split open at maturity on one side (USFWS, 2015).

**Taxonomy**

In the buttercup family (Ranunculaceae) (USFWS, 2015). Ewan (1942) described Delphinium bakeri based on type material collected by Milo Baker in 1939 from Coleman Valley, Sonoma County, California. In the most recent treatment, Warnock (1993) retained the taxon as a full species. (USFWS, 2000)

**Historical Range**

Marin and Sonoma Counties in California (USFWS, 2015).

**Current Range**

One natural site and three reintroduced sites in Marin County, California (USFWS, 2015).

**Critical Habitat Designated**

Yes; 4/17/2003.

**Legal Description**

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective April 17, 2003) for Delphinium bakeri (Baker's larkspur) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (68 FR 12834-12863).

**Critical Habitat Designation**

The critical habitat designation for Delphinium bakeri includes two CHUs in Sonoma and Marin Counties, California. Approximately 1,828 ac (740 ha) of Federal, State, and private land are being designated as critical habitat. Brief descriptions are presented below. Mapping coordinates and maps depicting the CH units are available in the Final Rule. (68 FR 12834-12863; USFWS, 2003)

Unit B1: Sonoma County, California. This unit is located near Coleman Valley Road west of the town of Occidental, approximately 8 km (5 mi) from the coast. The 322 ha (796 ac) unit is bounded on the north side by Coleman Valley Road and represents an area either near or at the original type locality for Delphinium bakeri. The exact location of the type locality for D. bakeri is somewhat vague, with the location described only as “Hedrin Ranch in Coleman Valley, West of Occidental.” The location is mapped to within a 1.6 km (1 mi) radius in the CNDDB. (USFWS, 2003)

Unit B2: Marin County, California. This unit is near the Marshall-Petaluma Road in Marin County approximately 10 km (6 mi) from the coast. This 418 ha (1,032 ac) unit is bounded on the north side by Salmon Creek and contains an extensive north-facing slope that is essential to maintaining the mesic conditions needed for the conservation of Delphinium bakeri. Land in this unit is privately owned with a county right-of-way along the road. (USFWS, 2003)

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Delphinium bakeri critical habitat consists of three components (68 FR 12834-12863):

(i) Soils that are derived from decomposed shale.

(ii) Plant communities that support associated species, including, but not limited to: Umbellularia californica (California bay), Aesculus californica (California buckeye), Quercus agrifolia (coastal live oak), Baccharis pulularis ssp. consanguinea (coyotebrush), Symphorcarpos cf. rivularis (snowberry), Rubus ursinus (California blackberry), Pteridium aqulinum (braken fern), Polystichum munitum (Sword fern), Pityrogramma triangularis (goldback fern), Dryopteris arguta (coastal woodfern), Adiantum jordanii (maidenhair fern), Polypodium glycyrrhiza (licorice fern), Toxicodendron diversilobum (poison oak), Ceanothus thyrsiflorus (blueblossom ceanothus), Lithophragma affine (woodland star), and Holodiscus discolor (oceanspray).

(iii) Mesic conditions on extensive north-facing slopes.

**Special Management Considerations or Protections**

Special management considerations or protections may be needed to maintain the physical and biological features and primary constituent elements that are essential for the conservation of Delphinium bakeri within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the species. ‘‘Special management considerations or protection’’ is a term that originates in the definition of critical habitat. The designated critical habitat units may require special management considerations or protection because remaining populations of Delphinium bakeri are extremely rare, contain few individuals, and are subject to threats which could extirpate the species. In addition to the risk due to random natural events that can result in the extinction of species with very few, small, and highly isolated populations, potential threats to the habitat of D. bakeri include overcollection, application of herbicides, and sheep grazing. Currently, no legally operative plans or agreements have been developed that address the maintenance and improvement of the primary constituent elements important to the species, or that provide management for the long-term conservation of D. bakeri. Outlined below are the most likely kinds of special management and protection that the habitat features and primary constituent elements essential to the conservation of Delphinium bakeri may require. The following actions apply to both species, unless otherwise noted: (1) In all plant communities where these taxa occur, invasive, nonnative species need to be actively controlled; (2) The quality of water must be maintained to keep it free from levels of herbicides or other chemical or organic contaminants that would be deleterious to the species; (3) Certain areas where these species occur may need to be fenced to protect them from accidental or intentional trampling by humans and livestock; (4) Aerial application of herbicides and insecticides that are likely to be deleterious to the species needs to be curtailed in the critical habitat. Exposure to deleterious herbicides and insecticides from drift needs to be avoided; (5) Existing hydrologic conditions may need to be protected by avoiding activities that cause a change in surface or subsurface water flows. (USFWS, 2003)

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowers from April into May (USFWS, 2015)

**Key Resources Needed for Breeding**

Adult: Bumblebees and hummingbirds for pollination (USFWS, 2015)

**Reproduction Narrative**

Adult: Baker's larkspur flowers from April into May. Known pollinators that have been observed visiting flowers of the reintroduced plants on several occasions include bumblebees (Family Apidae) and hummingbirds. Baker's larkspur is self-compatible, but requires visitation by pollinators for good quality and abundant seed set. The approximate foraging distance from their nest of most bumblebees is approximately 1 mile (USFWS, 2015).

**Habitat Type**

Adult: Terrestrial (USFWS, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Mixed woodland (USFWS, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevation range of 295 - 672 ft (USFWS, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Baker's larkspur occurs on decomposed shale in mixed woodland at an elevation range of 295 to 672 ft, in moderately moist, shaded conditions on a shallow veneer of soil along an extensive north-facing slope. These habitat requirements limit the availability of suitable reintroduction sites with appropriate habitat conditions and compatible land use (USFWS, 2015).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decline of >90% (NatureServe, 2015)

**Species Trends:**

Decline of >70% (NatureServe, 2015)

**Population Growth Rate:**

Low (inferred from NatureServe, 2015)

**Number of Populations:**

3 extant populations, 1 wild population, and 2 introduced populations (USFWS, 2024)

**Population Size:**

3 individuals (natural site); (USFWS, 2024)

**Population Narrative:**

As of 2018, there are three extant populations of Baker's larkspur, one historical population and two introduced populations. The single extant historical population of Baker's larkspur (CNDDB 2018, occurrence #1; along Marshall-Petaluma Road) has had fewer than five flowering plants each year since 2004. In 2018, the site contained only three plants of flowering size. However, there are signs that the habitat condition at this location has been gradually improving since the damage caused by fire and road maintenance activities in 2004 (H. Forbes, in litt. 2018a). Between 2009 and 2012, 203 adult, greenhouse-raised Baker's larkspurs were planted at three introduction sites, Marshall-Petaluma Road Private Ranch, Chileno Valley Road Private Ranch, and Soulajoule Reservoir (CNDDB 2018; occurrences #5, #6, and #7, respectively). Descriptions of the sites (all within 5 air miles of the historical occurrence) and details of the introductions can be found in the recovery plan for Baker's larkspur (USFWS 2015). As of 2018, none of the three introduced populations has been successful and only two remain extant. Although seedlings were documented at all introduction sites in the year(s) following out-planting, none of the seedlings produced on site have reached seed set (H. Forbes, in litt. 2018a). The Chileno Valley Road Private Ranch introduction site has supported 0 to 5 flowering plants each spring since 2012 but none of the plants has successfully set seed since 2013. In 2018, there were 25 adult Baker's larkspur plants at the Soulajoule Reservoir introduction site but no plants have flowered at this site since 2013. (USFWS, 2019). The Marshall-Petaluma Road population remains the only naturally occurring population of Baker's larkspur and only three flowering individuals were observed at this location in 2024 (H. Forbes unpubl. data 2024). The outplanted Baker's larkspurs in the three introduction sites have had low survivorship and population numbers have remained low at these locations (H. Forbes unpubl. data 2024). Conservation actions for this species since the last 5-year review have included seed banking, trimming invading vegetation around Baker's larkspur plants during monitoring visits, and growing Baker's larkspur plants in the nursery for future introduction efforts (H. Forbes in litt. 2024). As of 2024, the Botanical Garden has 80 Baker's larkspur plants growing in the nursery for use in future reintroduction efforts (H. Forbes in litt. 2024). The Botanical Garden also has approximately 0.5 million Baker's larkspur seeds banked at -18 degrees Celsius. Some of these seeds were collected from the naturally occurring population along Marshall-Petaluma Road (Table 1), but the majority of seeds were collected from plants grown at the Botanical Garden (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** After historical habitat loss, the most significant habitat impact activities are from maintenance crews (e.g., roadside vegetation clearing, fire control, culvert maintenance, etc.). Habitat alteration or loss as a result of establishment of nonnative vegetation presents a minor threat at this time. The three reintroduction sites were e specifically selected to avoid any current and anticipated land use conflicts, and require minimal stewardship activities (USFWS, 2015).

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Overutilization is a significant threat to this species. In 1992, all the capsules were collected from the plants at the only known site of Delphinium bakeri. Because these capsules contained the plants' seeds, all sexual reproduction for 1992 was lost. Were this collection to occur regularly or in conjunction with unrelated natural events (e.g., fire) the species may be lost (USFWS, 2012).

**Stressor:** Disease or predation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While most Delphinium species are toxic to cattle, the toxicity of Delphinium bakeri has not been tested; sheep grazining has been mentioned as a threat. Herbivory of Baker's larkspur by slugs, snails, and gophers is a significant threat to remaining individuals at small and vulnerable microsites (USFWS, 2015).

**Stressor:** Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Baker's larkspur is at risk from extirpation of small populations which may have endured reduced genetic variability and range constriction due to random natural and human-caused events. This species is also likely threatened by the effects of global climate change throughout its range (USFWS, 2015).

***Recovery***

**Reclassification Criteria:**

A.1. Habitat protection: Each reintroduced site will be managed for the species and in conservation ownership (owned in fee title), protected by a conservation easement, or protected by a formal Memorandum of Understanding with the landowner. Lands containing each population must be protected with a buffer of compatible land use. Due to the physical constraints of removing the threats presented by a major road, the Marshall-Petaluma Road Historical occurrence is exempted from this buffer requirement. (USFWS, 2015)

A.2. Outreach to reduce habitat disturbance: Outreach and education to the Marin County road maintenance crews and fire crews will ensure that the Marshall-Petaluma Road Historical Occurrence will no longer be affected by road or fire maintenance activities (USFWS, 2015).

C.1. Herbivory: For the 8 years following achievement of population targets, herbivory by slugs, snails and gophers must not occur in 2 consecutive years at levels which cause a population decline at any of the sites that count toward recovery. (USFWS, 2015)

E.1. Number of Sites/Geographic Distribution: For 5 consecutive years, a total of 12 self-sustaining populations of Baker's larkspur must be distributed across its historical range. This total may include the single extant historical occurrence and any newly discovered populations in addition to reintroduced populations. Microsites within the same reintroduction site may not be considered separate populations toward this total. Populations must be distributed between the Russian River to the north, Point Reyes-Petaluma Road to the south, the Pacific coast to the west and Highway 101 to the east. Marin and Sonoma counties must each support at least two populations of the species. For the purpose of the recovery plan, populations shall be considered separate if they are separated by at least 0.25 mi. (USFWS, 2015).

E.2. Number of Individuals: A minimum of 1,000 flowering individuals must be present at each of the 12 populations annually, for 5 consecutive years, and must include at least 2 lower-than-average water years. This reproductive objective for the minimum reproducing adult population may be met by a combination of surviving transplants and naturally recruited plants that mature and produce abundant seed annually. (USFWS, 2015)

E.3. Seedling Production: Each site must produce at least four seedling cohorts within 10 consecutive years that contribute enough surviving individuals to cause a net population increase at the site. Qualifying seed cohorts must not occur more than 3 years apart. The survival of subsequent generations of seedlings to reproductive maturity that produce viable seeds would demonstrate that plants at the site are completing their life-cycle without augmentation from propagation. Failure to detect surviving seedlings that mature into reproductive individuals within 3 years would indicate that the reintroduction is not yet achieving dynamic population objectives (Guerrant 1996). (USFWS, 2015).

Recovery Priority Number: 5

**Delisting Criteria:**
Development of delisting criteria is not possible given the current lack of information about the species' biology and habitat requirements, the magnitude of current threats, and the precarious environment where the single historical population of the species occurs (USFWS, 2015).

**Recovery Actions:**

- Monitoring of all known populations (including all microsites): Monitoring of the historical and reintroduction sites is necessary to determine population status and trends. Monitoring data will also be useful in helping to make informed decisions about site management and to determine progress toward reaching recovery criteria and objectives. (USFWS, 2015)
- Reintroduction of additional populations: Reintroductions should be conducted in accordance with the Service's Draft Baker's larkspur (Delphinium bakeri) Reintroduction Plan, Marin and Sonoma Counties, California, which describes the important components of site selection methodology, transplant procedures, seeding and labeling techniques, and reporting practices and should be updated as new information is gathered. (USFWS, 2015)
- Management of habitat at all populations. Reintroduction sites will be managed for the species and will be in conservation ownership, protected by a conservation easement, or protected by a formal Memorandum of Understanding with the landowner. This requirement (per relevant recovery criteria) will result in involvement with landowners or managers who are willing to allow flexibility in stewardship/management and monitoring activities, if the need arises, to ensure the population persists on their land. Reintroduction sites should be established where they are unlikely to be subject to human-related disturbance. However, if the site has a potential for vandalism, visible attractions (e.g. flags or flagging) should be removed and the reintroduced population should be disguised by surrounding the site with natural-looking accumulations of woody debris. (USFWS, 2015)
- Conduct research into Baker's larkspur genetics, population viability, and planting techniques (USFWS, 2015).
- Outreach: Due to the severe endemism and range restriction of Baker's larkspur, wide public outreach pertaining to its conservation is not a component of this recovery plan. Any outreach to a large audience that included detailed location information could endanger the species further by inadvertently drawing collectors, resulting in trampling impacts from the public, or infringing upon the privacy of participating landowners. However, recovery of the species is dependent upon willing landowners and managers who volunteer to conduct conservation activities on their lands. (USFWS, 2015)
- Recommended Future Action: Continue monitoring of the Marshall-Petaluma Road naturally occurring population and the three existing reintroduction sites at private ranches on Marshall-Petaluma and Chileno Valley Roads, and Marin Municipal Water District's Soulajoule Reservoir. (USFWS, 2012)
- Recommended Future Action: Continue seed multiplication and propagation efforts at the Garden. (USFWS, 2012)
- Recommended Future Action: Identify additional reintroduction sites and reintroduce Delphinium bakeri to at least two additional locations within its historic range. (USFWS, 2012)
- Recommended Future Action: The implementation of an adaptive strategy is recommended, whereby detailed observations of successes and failures are recorded and used to evaluate and adapt methods on a regular basis. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Baker's larkspur. Some of these recommendations have already been discussed in previous recovery documents (Service 2012, p. 15; Service 2015, pp. III-1 – III-7; Service 2019, p. 4) and remain valid. 1. Monitoring – Continue monitoring of the Marshall-Petaluma Road naturally occurring population and the three existing introduction sites at private ranches on MarshallPetaluma and Chileno Valley Roads, and Marin Municipal Water District's Soulajoule Reservoir. 2. Outreach to Marin County staff – Outreach and education to the Marin County road maintenance crews will help ensure that the naturally occurring Marshall-Petaluma Road occurrence will no longer be affected by road maintenance activities. 3. Seed banking and plant propagation – Continue seed multiplication and propagation efforts at the Botanical Garden. 4. Augment reintroduced populations with additional individuals – Conduct additional plantings and/or seeding at the three introduced sites to help bolster population numbers and improve chances of successful pollination and reproduction. 5. Identify additional reintroduction sites – Identify additional sites within the historical range of Baker's larkspur where suitable habitat conditions and compatible land use exist, for establishment of additional reintroduced populations. 6. Adaptive management – Due to the difficulty experienced thus far establishing introduced populations of Baker's larkspur, we recommend the implementation of an adaptive strategy, whereby detailed observations of successes and failures are recorded and used to evaluate and adapt methods for future introduction efforts. Research should be conducted in association with future introductions to determine what variables improve the survival of transplants. 7. Research – Conduct research on the genetic variability of Baker's larkspur to help inform future outplantings, as well as ecological research including the study of habitat requirements, life history parameters, and natural population fluctuations (USFWS, 2024).

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# SPECIES ACCOUNT: *Delphinium luteum* (Yellow larkspur)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 1/26/2000; Pacific Southwest Region (R8) (USFWS, 2015)

**Physical Description**

A perennial herb that grows from fibrous roots to 56 centimeters (22 inches) tall. The leaves are mostly basal, fleshy, and green at the time of flowering, which occurs from March to May. The flowers are cornucopia shaped with five conspicuous bright yellow sepals, with the posterior sepal elongated into a spur. The inconspicuous petals occur in two pairs: the upper petals are narrow and unlobed and the lower petals are oblong to ovate. The fruit is a follicle (USFWS, 2011).

**Taxonomy**

In the buttercup family (Ranunculaceae). Although Jepson (1975) reduced D. luteum to a variety of D. nudicaule (red larkspur), it is currently recognized as a full species (Warnock 1993) (USFWS, 2011).

**Historical Range**

See current range/distribution.

**Current Range**

Historically occurred within northwestern Marin and southwestern Sonoma counties, California (USFWS, 2011).

**Critical Habitat Designated**

Yes; 3/18/2003.

**Legal Description**

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Delphinium luteum (Yellow larkspur) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (68 FR 12834-12863).

**Critical Habitat Designation**

The critical habitat designation for Delphinium luteum includes three CHUs in Sonoma and Marin Counties, California. Approximately 2,525 ac (1,022 ha) of Federal, State, and private land are being designated as critical habitat for Delphinium luteum. (68 FR 12834-12863).

Unit L1: Bodega Bay, Sonoma County, California.

Unit L2: Estero Americano, Marin County, California

Unit L3: Estero de San Antonio, Marin County, California

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Delphinium luteum critical habitat consists of four components (68 FR 12834-12863):

(i) Plant communities, including north coastal scrub or coastal prairie communities, including but not limited to: Arabis blepharophylla (rose rockcress), Calochortus tolmei (Tolmei startulip), Mimulus aurantiacus (orange bush monkeyflower), Dudleya caespitosa (sea lettuce), Polypodium californicum (California polyploidy), Eriogonum parviflorum (sea cliff buckwheat), Toxicodendron diversilobum (poison oak), Romanzoffia californica (California mistmaiden), Hesperevax sparsiflora (evax), Pentagramma triangularis (goldenback fern), and Sedum spathulifolium (broadleaf stonecrop).

(ii) Relatively steep sloped soils (30 percent or greater) derived from sandstone or shale, with rapid runoff and high erosion potential, such as Kneeland or Yorkville series soils.

(iii) Generally north aspected areas; and

(iv) Habitat upslope and downslope from known populations to maintain disturbance such as occasional rock slides or soil slumping that the species appears to require.

**Special Management Considerations or Protections**

Special management considerations or protections may be needed to maintain the physical and biological features and primary constituent elements that are essential for the conservation of Delphinium bakeri and D. luteum within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two species. As noted in the Critical Habitat section, ‘‘special management considerations or protection’’ is a term that originates in the definition of critical habitat. We believe the designated critical habitat units may require special management considerations or protection because remaining populations of Delphinium bakeri and D. luteum are extremely rare, contain few individuals, and are subject to threats which could extirpate them. In addition to the risk due to random natural events that can result in the extinction of species with very few, small, and highly isolated populations, potential threats to the habitat of D. bakeri include overcollection, application of herbicides, and sheep grazing, and potential threats to the habitat of D. luteum include overcollection, road widening, sheep grazing, fire suppression, and hybridization. Currently, no legally operative plans or agreements have been developed that address the maintenance and improvement of the primary constituent elements important to the species, or that provide management for the long-term conservation of D. bakeri or D. luteum. We have outlined below the most likely kinds of special management and protection that the habitat features and primary constituent elements essential to the conservation of Delphinium bakeri and D. luteum may require. The following actions apply to both species, unless otherwise noted: (1) In all plant communities where these taxa occur, invasive, nonnative species need to be actively controlled; (2) The quality of water must be maintained to keep it free from levels of herbicides or other chemical or organic contaminants that would be deleterious to the species; (3) Certain areas where these species occur may need to be fenced to protect them from accidental or intentional trampling by humans and livestock; (4) Aerial application of herbicides and insecticides that are likely to be deleterious to the species needs to be curtailed in the critical habitat. Exposure to deleterious herbicides and insecticides from drift needs to be avoided; (5) The appropriate level of soil disturbance needs to be maintained (this applies only to Delphinium luteum); and (6) Existing hydrologic conditions may need to be protected by avoiding activities that cause a change in surface or subsurface water flows.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: Probably at least 10 years (USFWS, 2011)

**Breeding Season**

Adult: Flowers from March to May (USFWS, 2011)

**Key Resources Needed for Breeding**

Adult: Hummingbirds (and possibly bumblebees) for pollination (USFWS, 2011)

**Reproduction Narrative**

Adult: Flowering is from March to May. Hummingbirds (and possibly bumblebees) for pollination. Lifespan is unknown, but is at least 10 years. (USFWS, 2011).

**Habitat Type**

Adult: Terrestrial (USFWS, 2011)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal prairie and coastal scrub areas, which typically have no overstory vegetation (USFWS, 2011)

**Dependencies on Specific Environmental Elements**

Adult: Moderate to steep slopes, generally near areas showing evidence of some level of ground disturbance in the past (USFWS, 2011).

**Geographic or Habitat Restraints or Barriers**

Adult: Elevations ranging from sea level to 300 ft (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2003)

**Habitat Narrative**

Adult: The species occurs in Coastal prairie and coastal scrub areas, which typically have no overstory vegetation, on moderate to steep slopes, at elevations ranging from sea level to 300 ft, and are generally near areas showing evidence of some level of ground disturbance in the past, including landslides. Typical soil types include the Kneeland series in Sonoma County and the Yorkville series in Marin County. These soils derive from sandstone or shale, and share qualities of rapid runoff and high erosion potential (USFWS, 2011). Primary constituent elements of critical habitat include Relatively steep sloped soils (30 percent or greater) derived from sandstone or shale, with rapid runoff and high erosion potential, such as Kneeland or Yorkville series soils; generally north aspected areas, and habitat upslope and downslope from known populations to maintain disturbance that the species appears to require (USFWS, 2003).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal information is not described in the 5-year review (USFWS, 2011).

***Population Information and Trends***

**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

**Species Trends:**

Decline of 30-50% (NatureServe, 2015)

**Resiliency:**

The small size of populations of yellow larkspur in the wild makes the species extremely vulnerable to stochastic events. What would generally be considered stochastic events for wideranging populations could be catastrophic for smaller populations (Gilpin and Soule 1986, pp. 25–31; Service 2000, pp. 4159–4160). There is also the potential for additional effects related to small population sizes. Small populations have a higher risk of inbreeding due to reduced numbers of individuals available for reproduction. Inbreeding can reduce fitness, making populations less able to adapt to a variable environment (Shaffer 1981, p. 133; Ellstrand and Elam 1993, p. 225). Though Koontz et al. (2001, p. 1614) found relatively high genetic diversity in yellow larkspur populations, decreasing numbers of individuals still indicates the possibility of inbreeding (USFWS, 2024)

**Representation:**

Yellow larkspur genetic representation is high, as the species has been shown to maintain high levels of genetic variation (Koontz et al. 2001, p. 1614). Yellow larkspur has been found in two soil types: Kneeland series in Sonoma County and Yorkville series in Marin County, suggesting it has some ecological representation. The most recently documented populations (those located in the 1980's or later) tend to grow on north-facing slopes in canyon complexes with steep sides (Diversity Database 2023). Ecological representation is moderate due to the high level of genetic variation but assumed narrow range of habitat suitability and limited distribution. (USFWS, 2024)

**Redundancy:**

Redundancy is often limited for local, endemic species with a naturally limited range. Larkspur Rock is currently the only stable population of yellow larkspur. Previously documented occurrences on private land may still be extant, but without access, we are unable to confirm presence/absence. A catastrophic event impacting the population at Larkspur Rock could lead to extirpation of the only protected site (or extinction in the wild, depending on the status of the other yellow larkspur occurrences). Overall, the species currently has low redundancy (USFWS, 2024)

**Number of Populations:**

2 extant (USFWS, 2024)

**Population Size:**

Approx 200 individuals (USFWS, 2011)

**Additional Population-level Information:**

Only 3 of the 11 occurrences have records since 1993. (USFWS, 2024)

**Population Narrative:**

As described in Chapter 4 of the SSA report, of the eleven total Diversity Database occurrences for yellow larkspur, only three have records since 1993: Larkspur Rock (#5), Larkspur Hill (#11), and Walker Creek (#14; Diversity Database 2024). Several of the historical populations occur on private land and access would need to be granted by landowners to survey. The Larkspur Rock location is the only extant population of yellow larkspur that is known to be stable. The Larkspur Rock population is in Sonoma County and is protected as a conservation easement and monitored annually by University of California Botanical Garden at Berkeley (hereafter Botanical Garden) staff (H. Forbes in litt. 2023). The number of plants at this location fluctuates but has remained relatively stable at about 60 individuals for the past 10 years (Service 2024a, p. 18). The Larkspur Hill location is in Sonoma County on privately-owned lands and has not been visited since 1987 but 5–10 plants were observed from the road in 1999 (Service 2019, p. 2). The yellow larkspur population at Larkspur Hill is presumed extirpated because blooming plants have not been visible from the highway since before 2011 and the property’s management practices are incompatible with yellow larkspur persistence (Service 2019, p. 2). This property is currently managed as a sheep ranch, and plants are threatened by grazing (Service 2011, pp. 5–6). The Walker Creek occurrence is a roadside population in Marin County. Two yellow larkspurs were observed at this location in 2016 and one was observed in 2018, 2021, 2022, and 2023 (Service 2019, p. 2; D. Greenberger in litt. 2023; V. Smith in litt. 2023). In the past, yellow larkspur at this location has co-occurred with red larkspur (Delphinium nudicaule) and it is believed that the single, yellow-flowered larkspur observed at this location over the past six years is the same individual and is a hybrid between yellow larkspur and red larkspur (D. Greenberger in litt. 2023; D. Smith in litt. 2023; H. Forbes in litt. 2023) (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat destruction is still considered the greatest immediate threat for Delphinium luteum, with quarry activities, erosion, and disturbance of roadside locations listed as factors (USFWS, 2011).

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** At the time of Listing Rule in 2000, unrestricted collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants was said to be a threat (65 FR 4156). Overcollecting may still be a threat. Delphinium luteum is the only known yellow flowered larkspur. Due to this distinctive morphology, it has been and continues to be of horticultural interest, and some of the historical decline to D. luteum can be attributed to overcollecting (USFWS, 2011).

**Stressor:** Disease or predation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Predation remains a threat for populations located on sheep grazing land. Most Delphinium species are toxic to cattle but not sheep. Several populations may be threatened by sheep grazing (USFWS, 2011).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Federal Endangered Species Act is the primary Federal law that provides protection for Delphinium luteum since it was considered endangered with the Listing Rule of 2000. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, other laws and regulations have limited ability to protect the species in absence of the Act (USFWS, 2011).

**Stressor:** Risk of extirpation due to small population sizes (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The small number of individuals in the single Delphinium luteum population increases the threat of extinction of the species as a whole through stochastic demographic and environmental events. Delphinium has been reduced to a few unprotected populations with fluctuating numbers of individuals (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Global climate change is a potential threat to Delphinium luteum. Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2011).

**Stressor:** Competition with native and non-native vegetation (USFWS, 2024)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** The introduction of non-native, invasive plant species can reduce the habitat quality of native communities, including coastal scrub and coastal prairie (Ford and Hayes 2007, p. 187). Under grazing pressure, non-native perennial grasses will often replace native coastal scrub species, thus directly competing for space with native species. Invasive plant species were listed as a threat in the 2019 5-year review and continue to threaten yellow larkspur (Service 2019, p. 9). At Larkspur Rock, ripgut brome (Bromus diandrus), an invasive grass species, has been increasing in cover and is considered one of the primary threats to this population (H. Forbes in litt. 2023). Additionally, poison oak, a native species, has shaded out some areas of rock that previously supported yellow larkspur (H. Forbes in litt. 2023). Native plants may also be a threat if they outcompete yellow larkspur or negatively impact habitat suitability. (USFWS, 2024)

**Stressor:** Hybridization (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hybridization was first listed as a threat to yellow larkspur in the 2003 critical habitat designation (Service 2003, p. 12836) and remains a threat to the species. Hybridization with other Delphinium species is a threat to the conservation of unique yellow larkspur genotypes, especially where yellow larkspurs are known to occur with the closely related, interfertile red larkspur (Diversity Database #'s 13, 14, 16, and 17; Guerrant 1978, p. 1; Service 2019, p. 9; Diversity Database 2023). (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8C

Yellow larkspur may be considered for downlisting when all the following criteria are met: 1a. There are a minimum of six populations in moderate condition as defined in the current SSA. For the purposes of this recovery plan, populations will be considered separate if they are separated by at least 0.25 mile (0.4 kilometer; km). -or1b. There are a minimum of four populations in high condition as defined in the current SSA. For the purposes of this recovery plan, populations will be considered separate if they are separated by at least 0.25 mile (0.4 km)1 (USFWS, 2025) .

2. The populations described in downlisting criterion 1a or 1b are protected and management is shown to be effective by stable or increasing population trends based on a minimum of 10 years of data. (USFWS, 2025)

**Delisting Criteria:**
1. A minimum of eight populations, six of which are in high condition as defined in the current SSA, and the remaining of which are at least in moderate condition. For the purposes of this recovery plan, populations will be considered separate if they are separated by at least 0.25 mile (0.4 km). (USFWS, 2025)

2. A distance of at least 15 miles (24 km) must separate the two furthest populations described in delisting criterion 1. This span must include at least one permanent firebreak (e.g., road or

waterway) to decrease the chance of catastrophic wildfire affecting all populations2. (USFWS, 2025)

3. The populations described in delisting criterion 1 are protected and management is shown to be effective by stable or increasing population trends based on a minimum of 20 years of data. (USFWS, 2025)

4. Ex situ seed collections are established at a Center for Plant Conservation seed bank facility. The seed collections are of sufficient size and genetic diversity to support research, restoration, viability testing, and the establishment of a backup collection at the National Laboratory for Genetic Resources Preservation, Fort Collins, CO. Accessions are replenished every 15 years, unless research demonstrates that collection frequency should be more frequent. (USFWS, 2025)

**Recovery Actions:**

- Gather information on habitat needs and requirements. Little is known about the habitat needs and requirements for Delphinium luteum. All wild populations grow on north-facing rocky slopes in Sonoma or Marin counties, but the plant is grown easily in horticulture. Research to gather information about soil and moisture requirements, pollination and germination requirements and viability of the seed bank is recommended (USFWS, 2011).
- Continue captive propagation efforts for Delphinium luteum at the University of California Botanical Garden at Berkeley (USFWS, 2011).
- Write a Recovery Plan. The Act requires that all listed species have recovery plans. Delphinium luteum has been listed since 2000, development of a recovery plan would provide guidance to conservation efforts already in progress and provide criteria for successful recovery of the species (USFWS, 2011).
- Pursue communication with landowners for access to survey plants. Some of the CNDDB occurrences are on private property and have not been observed in many years. The Service recommends communicating with landowners to negotiate access to their properties to survey for plants (USFWS, 2011).
- Yearly surveys of plants. Currently there is little knowledge about the numbers of plants and populations of Delphinium luteum. The Service recommends yearly surveys of sites listed in the CNDDB in addition to sites on north-facing rocky slopes that may have unknown populations of D. luteum. With yearly surveys the Service can establish basic knowledge of the population numbers and range of the species, in addition to more information about any changes in habitat, a more comprehensive threats analysis and an estimation of the population trends of the species (declining, stable, or increasing) (USFWS, 2011).
- Find appropriate reintroduction sites. Survey for reintroduction sites on protected property and pursue landowner agreements (USFWS, 2011).
- Not available.
- 1. Reintroduce yellow larkspur to additional sites in appropriate habitat within protected areas throughout its historical range (Priority 1). (USFWS, 2025)
- 2. Develop and implement a monitoring program to identify population trajectories and environmental conditions that might be adversely affecting the species throughout its range (Priority 1). (USFWS, 2025)
- 3. Manage habitat that supports the species to reduce or eliminate threats, including control of competitive non-native vegetation, control of encroaching competitive native vegetation,

and supplemental seeding or planting throughout its range (Priority 1). (USFWS, 2025)

- 4. Collect seed from populations throughout the species' range and deposit accessions into two permanent conservation seed banks (Priority 2). (USFWS, 2025)
- 5. Conduct needed experimental research projects to enhance and improve management actions throughout the species' range. Examples include those that examine yellow larkspur genetics, assess population viability and habitat requirements, and evaluate planting techniques (Priority 3). (USFWS, 2025)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue annual monitoring of Larkspur Rock population (Recovery Action 2). Yearly monitoring of the yellow larkspur population at Larkspur Rock has been conducted by Botanical Garden staff since 2011 (Service 2024a, p. 18). Annual monitoring data is used to demonstrate population trends. • Control competing vegetation at Larkspur Rock (Recovery Action 3). Habitat management at Larkspur Rock has consisted of pulling weeds and trimming poison-oak (Toxicodendron diversilobum) during annual monitoring visits by Botanical Garden staff. In the last few years, poison oak has shaded out some areas of rock that previously supported yellow larkspur, requiring additional trimming/removal to allow yellow larkspur to recolonize these areas (H. Forbes in litt. 2023). • Continue captive propagation and seed banking (Recovery Action 4). The Botanical Garden maintains a yellow larkspur seed bank that was started in 1983 from seeds collected at Larkspur Rock (Service 2011, p. 6). Botanical Garden staff have stored approximately 5,000 primarily nursery-generated seeds for use in long-term storage and for conservation projects (Botanical Garden 2023, p. 5). Additionally, Botanical Garden staff have identified ideal nursery germination conditions and have successfully grown yellow larkspur in the nursery for several decades. As of 2023, the Botanical Garden had approximately 100 plants which could be used for outplanting (Botanical Garden 2023, p. 5). Continued propagation will be crucial for future outplanting efforts which will likely be necessary to achieve recovery. • Reintroduce yellow larkspur to additional sites in appropriate habitat within protected areas throughout its historical range (Recovery Action 1). Potentially suitable habitat for yellow larkspur has been identified at Point Reyes National Seashore and on a Wildlands Conservancy property in Jenner Headlands. Further coordination and planning with appropriate land managers are required prior to project initiation (Holly Forbes pers. comm. 2023). • Conduct research on the habitat requirements for yellow larkspur (Recovery Action 5). Research conducted in conjunction with future reintroductions in areas with varying microhabitats (type/level of disturbance, slope, aspect, plant community composition, etc.) would clarify habitat requirements for this species and help identify suitable locations for future outplantings. • Pursue communication with landowners for access to survey plants. Some of the Diversity Database occurrences are on private property and have not been observed in many years. Communicating with landowners to negotiate access to their properties to survey for plants would allow the Service to confirm the presence/absence of these historical populations (USFWS, 2024)

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# SPECIES ACCOUNT: *Dicerandra christmanii* (Garrett's mint)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 9/21/1989; Southeast Region (R4)

**Physical Description**

Dicerandra christmanii is a small, fragrant shrub that reaches 50 cm in height (Huck et al. 1989). Both its floriferous and vegetative shoots are stiff and ascend from a ramose (many branched, branching), woody base. Its taproot is branched with extensive, spreading, fibrous roots. The leaves of Garrett's mint are sessile and have rounded apices, cuneate bases, entire margins and glandularpitted upper and lower surfaces (Huck et al. 1989). Leaves found on the determinate, flowering shoots are narrowly ovate to narrowly oblong. Those that subtend the cymes are 2 to 8 mm long and 0.5 to 1.8 mm wide, while those that do not subtend the cymes are approximately 5 to 11 mm long, and 1 to 2.5 mm wide. The leaves of overwintering, vegetative shoots are similarly shaped, but larger. The inflorescence is a verticillaster (Huck et al. 1989), with each cyme containing 1 to 3 flowers. The calyx is 6.5 to 10 mm long, approximately 2 mm wide (at midpoint), and bordered with an indistinct white band. The corolla is funnel shaped and abruptly bent to about 90 degrees. Its tube is 7 to 10 mm long, and its limb (from geniculum to distal edge of upper lobe) is 5 to 10 mm long. The corolla buds yellow, but at maturity, it is a pale cream (eventually fading to white). It has vivid purple-red markings that are often trellise-patterned on the upper lobe, but irregularly spotted on the lower lobe. The upper lobe is a recurving, cleft standard, and the lower lobe is tripartite (three parted) with a recurving middle petal. The flowers have four, paired stamens, which are exerted slightly beyond the lower corolla lip (Huck et al. 1989). The filaments are white, the anther sacs are brilliant yellow, and the connective is widened and may be covered with a few small, reddish and yellow glands at the basal end. The pollen is white and sticky. The pistil is white and has a slender, hirtellous style. The fruit is a schizocarp of four ovoid, brown, smooth nutlets. (USFWS, 1999)

**Taxonomy**

Specimens of D. christmanii were first collected by Garrett in 1948 east of Sebring and originally identified as D. frutescens by Ward (1979), Wunderlin (1984), and Huck (1987). D. christmanii was named as a distinct species in 1989 (Huck et al. 1989). (USFWS, 1999)

**Historical Range**

The historic distribution of Garrett's mint was along a 6-km section of an ancient yellow-sand ridge that has only been fragmented within the last 40 to 60 years (Menges et al. 2001). (USFWS, 2009)

**Current Range**

In Highlands County, Florida, between Lake Jackson and Lake Istokpoga. (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowers from July to November, primarily in September and October (USFWS, 1999)

**Reproduction Narrative**

Adult: Dicerandra christmanii flowers from July to November, primarily in September and October (Huck et al. 1989). Like other Dicerandra species, it has spurred anthers which must be triggered by insects for the pollen to be released and dispersed (FWS 1987). This pollination process occurs mainly through bee-flies (Exoprosopa fasciata), and few other insects visit the plant (Huck et al. 1989). (USFWS, 1999)

**Habitat Type**

Adult: Pine Scrub/Oak-hickory scrub

**Environmental Specificity**

Adult: Very Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Dicerandra christmanii is found within openings in sclerophyllous oak scrub (Huck et al. 1989). As a "gap" species, it prefers open areas and does not grow vigorously when in shaded conditions. The species occurs on well-to excessively drained yellow sands of Astatula and Tavares soil types and is found where the seasonal high water table is at least 1 to 2 m deep. (USFWS, 1999)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: The seeds do not have mechanisms for wind dispersal and generally fall close to the plant (R. Huck, personal communication, 1996). Some Dicerandra species have been shown to use water as a dispersal agent, sometimes having their seeds carried by streams (Huck 1987). However, the limited distributions of D. christmanii, D. frutescens, and D. immaculata indicate that this mechanism is not effective in South Florida. Given this limited dispersal, colonization of a newly disturbed area by D. christmanii depends on whether or not it is present in the seedbank. The lifespan of seeds in the seedbank is unknown. (USFWS, 1999)

***Population Information and Trends***

**Number of Populations:**

Four

**Population Size:**

3,891

**Population Narrative:**

The loss of scrub on the Lake Wales Ridge habitat was the primary reason for listing Garrett's mint as endangered. Garrett's mint is known from four sites, all occurring in a 6-km (3.7 mi) (north to south) by 3-km (1.9 mi) (east to west) area of Highlands County, Florida (FNAI 2009). The species is poorly represented on conservation land. Only one of the four occurrences is located within a protected area at the Flamingo Villas unit of the LWRNWR (Service 1999a, FNAI 2009). Three of four occurrences are located on private land. The area in the vicinity of these occurrences has been largely converted to citrus groves and scattered single family residences. Fire suppression continues to be a threat to Garrett's mint populations because the species thrives in the open conditions (gaps between shrubs) created and maintained by fire (Menges et al. 1999; Evans et al. 2004; Menges et al. 2006; Evans et al. 2008). At Flamingo Villas, estimates of the number of plants in the population began in 1994. From 1994 to 1998, the number of plants ranged from 2,266 to 3,507 (Menges and Weekly 1999). In 2009, a complete census of the population located 3,891 plants (Bok Tower Gardens 2010). Work is still required to complete land acquisition, control unauthorized access, remove trash, and restore the scrub vegetation with prescribed fire. Garrett's mint occurs at 'Carter Creek East', also known as 'Sebring Railroad East Scrub', a parcel targeted for acquisition by the Florida Forever program (FDEP 2008). The site is a 40-acre block of scrub located adjacent to a railroad track in a relatively remote area with no nearby public roads (Schultz et al. 1999). A large and thriving population of Garrett's mint was extant on this site as of October 2010 (C. Peterson, Bok Tower Garden, pers. comm. 2010). The occurrence in the vicinity of Moon Ranch Road is in an area lightly developed with single-family residences. Access for surveys was denied in 2009 (Bok Tower Gardens 2010). Remaining nearby scrub habitat may still support Garrett's mint. The occurrence in the vicinity of Snyder Road is extant along the roadside and on parcels that still contain habitat. Plants on the roadside are subjected to occasional mowing. The population consisted of a mere 88 plants in October 2009. Most of the surrounding area is converted to citrus groves and heavily disturbed (Bok Tower Gardens 2010).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019

**Stressor:** Lack of adequate fire management
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of D. christmanii are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the seral stage of xeric oak scrub that supports D. christmanii (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

**Delisting Criteria:**
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution of D. christmanii. Conduct surveys for additional populations of D. christmanii. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Monitor existing populations of D. christmanii. Develop monitoring protocol to assess population trends for D. christmanii. Develop a quantitative description of the population structure of D. christmanii. Monitor re-introduced plants. (USFWS, 1999)
- Provide public information about D. christmanii. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of D. christmanii. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. christmanii and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Secure habitat through acquisition, landowner agreements, and conservation easements. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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# SPECIES ACCOUNT: *Dicerandra cornutissima* (Longspurred mint)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/1/1985; Southeast Region (R4) (USFWS, 2015

**Physical Description**

A pungently aromatic, low shrub from a woody taproot. Leaves are opposite, needle-like, mostly ascending, with margins that are sometimes slightly wavy. The inflorescence appears as a narrow system of axillary clusters, each with 1-5 flowers. Flower petals are rose-purple, strongly 2-lipped, about 13 mm long. (Based on Kral 1983.) (NatureServe, 2015).

**Taxonomy**

Distinct species; one of six in Florida (NatureServe, 2015). Dicerandra is a genus of seven species in the mint family (Lamiaceae or Labiatae) (USFWS, 1987).

**Historical Range**

Originally found in Marion and Sumter Counties (USFWS, 2008).

**Current Range**

Currently known to occur at four sites in Marion County: CFG, along the I-7S right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision (USFWS, 2008).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 1987)

**Dependency on Other Individuals or Species**

Adult: Apidae spp. (USFWS, 1987)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 1987)

**Reproduction Narrative**

Adult: The three perennial species of Dicerandra are obligate outcrossers that reproduce entirely by seed (Huck 1984). Each has spurred anthers, which must be triggered by insect pollen vectors (usually the Apidae) for pollen to be released and dispersed (Huck 1984).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Longleaf pine-turkey oak scrub/sandhill, slash pine-palmetto scrub (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Scattered in openings (natural or artificial) in longleaf pine-turkey oak scrub/sandhill or on low rises in slash pine-palmetto scrub. (Based on Kral 1983.) (NatureServe, 2015). The habitat occupied by this species needs periodic prescribed fires. D. cornutissima grows well in open, sandy patches usually along roadside edges (USFWS, 2008).; D. cornutissima is endemic to sand pine scrub habitat that can best be described as scrub composed of overstory of older mature sand pine (Pinus clausa), with an open to thick understory of sand live oak (Quercus geminate), Chapman's oak (Q. chapmanii), myrtle oak (Q. myrtifolia), saw palmetto (Serenoa repens), scrub palmetto (Sabal etonia), Florida rosemary (Ceratiola ericoides), and the state listed Garberia heterophylla (Herring 2005). The ground cover component of this habitat is composed of patchy occurrences of lichens ( Cladina evansii, Cladina subtenuis, and Cladonia leporine), as well as grasses such as wiregrass (Aristida stricta), arrowfeather threeawn (Aristida purpurescens ), and sandy field beaksedge (Rhynchospora megalocarpa). D. cornutissima grows well in open, sandy patches usually along roadside edges. Although D. cornutissima occurs in a fire-adapted habitat, the timing of fires related to the plants survivorship and reproduction is not known (Herring 2005). At CFG, D. cornutissima mostly occurs within sand pinedominated scrub that has a mosaic of sandhill throughout the site (Herring 2005). The overstory is open, consisting of mostly sand pine, but longleaf pines are occasionally found. Fire suppression in the sandhill has led to an invasion of sand pine, but prescribed burning of this area needs to be conducted carefully, since response of D. cornutissima is unknown (Herring 2005). Menges (1992) found that a similar species, D. frutescens, a short-lived perennial is killed by fire and reestablishes vigorously from seed. Weekley (2006) notes its close relative D. christmanii is also killed by fire and reestablishes from seed. There has recently been research (K. Holsinger, University of Connecticut, unpublished data, 2008) to show that longer intervals of fire (more than 12 years) may be optimum for these species. Therefore, research on the similar D. frutescens, which grows in yellow sand scrub at Archbold Biological Station on the Lake Wales Ridge, should be considered to elucidate the effects of fire on Dicerandra species and help refine prescribed burning activities (A. Johnson, FNAI, personal communication, 2008). Further east on the CFG, along the I-75 right-of-way, and Marion Oaks and Ocala Waterway Estates subdivisions, D. cornutissima occurs along roadside edges, its preferred habitat (Herring 2005). Care must be taken along these edges to not move dirt, mow, and establish fire lines with heavy equipment (Herring 2005). There are plans at CFG to manage the scrub habitat using mechanical means to open the habitat and reduce the sand pine. Due to the close proximity of I-75 to this site, prescribed burning is extremely difficult. The OGT recently completed a management plan for CFG that has goals and objectives to protect, enhance, and increase D. cornutissima found on the site (FDEP 2007). (USFWS, 2016)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Unknown (USFWS, 2008)

**Number of Populations:**

6 (USFWS, 2023)

**Population Size:**

~37,134 to 42,874 (USFWS, 2023)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

the species status is unknown; the last comprehensive population survey was completed in 1991. During the 2005 FNAI survey, a total of 731 plants were documented on the FDOT 1-75 right-of-way. Four sites of D. cornutissima are known to occur in Marion county, FL (USFWS, 2008). This species has few individuals and a very restricted range, and is experiencing a reduction in habitat from development pressures (NatureServe, 2015).; D. cornutissima was originally found in Marion and Sumter Counties. Currently D. cornutissima is only known to occur at four sites in Marion County: CFG, along the I-75 right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision. A survey of the historic locations of D. cornutissima in Sumter County was conducted in 1984 and no plants were found (Wunderlin 1984). Florida Natural Areas Inventory (FNAI) has a record of D. cornutissima south of Marion Oaks along a powerline in Sumter County in 1988. The site along the powerline was discovered after the recovery plan was written in 1987. The recovery plan states that there was no suitable habitat left at the sites surveyed in 1984 in Sumter County, although suitable habitat may still exist between Sumter County and southern Marion County. (USFWS 1987, Wunderlin 1984). Other FNAI records include plants on private lands in Marion County near Rainbow Lakes Estates in 1993 and along State Road 200 (Bahia Oaks development) in 1991. No surveys of these sites have occurred since the early 1990s. Adjacent protected lands (Ross Prairie State Forest, Halpata Tastanaki Preserve, and Potts Preserve) have been surveyed the past five years but no D. cornutissima have been located in suitable habitat at these locations (A. Johnson, FNAI, personnel communication, 2008). (USFWS, 2018). Current distribution includes six extant D. cornutissima populations on public and private lands in Marion and Sumter counties, Florida. Based on the most recent estimates, there may be approximately 37,134 to 42,874 or more individuals in those six populations (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Habitat destruction remains the greatest threat to D. cornutissima. Populations along the I-75 right-of-way have been impacted by road construction, exotic plant invasion, and other road-related activities. The other two remaining sites are on private property and are susceptible to destruction due to urban development. Without natural caused or prescribed fires, sand pine creates a dense overstory, making the habitat unsuitable for D. cornutissima (USFWS, 2008).

**Stressor:** Invasive species (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The introduction of cogon grass along the I-75 right-of-way as well as on a few sites in the CFG in areas occupied by D. cornutissima has reduced the amount of suitable habitat for this species (USFWS, 2008).

**Stressor:** Fire suppression (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs mainly along areas that have been naturally maintained with fire. Where fire has been suppressed for long periods, canopy cover increase and understory vegetation increases, reducing open sandy patches. The majority of sites containing D. cornutissima are degraded due t fire exclusion or lack of mechanical vegetative management (USFWS, 2008).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Florida Administrative Code 5B-40 (Preservation of Native Flora in Florida) provides the Florida Department of Agriculture and Consumer Services with limited authority to protect these plants (primarily from the standpoint of illegal harvest) on state and private lands. Only a few populations of D. cornutissima are located on protected land (CFO) where they are being managed. The FDOT is managing the I-75 right-of-way by controlling exotics however the right-of-way would not be considered protected land. CFO was acquired by the State of Florida in 1991, after Congress de-authorized the Cross Florida Barge Canal construction and transferred all the lands to the State. CFO has an approved unit management plan in place to protect D. cornutissima (FDEP 2007). FDOT currently manages for D. cornutissima along the I-75 right-of-way by working with their contractors that mow this right-of-way to avoid routine mowing outside the highway clear zone (approximately 36 feet from the travel lanes) and to control the cogon grass found on the right-of-way. A monitoring and management program should be established, including experimentation with different regimes of vegetation management outside the clear zone and re-establishment of an extirpated cluster of D. cornutissima that occurred within the southbound rest area before the construction. Two of the populations occur on private lands with little to no protection. The Service's Partners for Fish and Wildlife program could work with these landowners to better manage and protect these populations. (USFWS, 2018)

***Recovery***

**Reclassification Criteria:**
Ten separate, self-sustaining populations of the species are established at secure sites in peninsular Florida. This numerical goal is subject to revision as information becomes available on the population biology of each species and as suitable sites are found (USFWS, 1987).

**Delisting Criteria:**
20 separate, self-sustaining populations are established at secure sites in peninsular Florida (USFWS, 2008).

**Recovery Actions:**
- Protect and manage existing population (USFWS, 1987).
- Conserve germ plasm (USFWS, 1987).
- Establish and manage new populations (USFWS, 1987).
- 1. Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing and/or eliminating threats to D. cornutissima as well as updated information on the species distribution, biology, and management needs. (USFWS, 2018)
- 2. Support further research on: a) the effects of prescribed burning and other management tools on D. cornutissima. Continue working with public land managers to increase management efforts to benefit D. cornutissirna on their sites. b) Additional life history needs. Additional information is needed on how cogon grass and other invasive plants affect D. cornutissima plants and what the effects of the herbicides used to eradicate cogon grass have on this species. c) The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitat. d) The various pollinators ( e.g., Hymenoptera and Lepidoptera), as well as how different ant species assist with seed dispersal. (USFSW, 2018)
- 3. Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program. (USFWS, 2018)
- 4. Complete a rangewide survey to find all known and potential sites occupied by D. cornutissima and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions. (USFWS, 2018)
- 5. Consider reintroduction and monitoring of D. cornutissima on additional publicly owned lands with suitable habitat. Reintroduction of D. cornutissima could help to increase the number of populations on protected sites and augment populations \Vhere needed. (USFWS, 2018)
- Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing and/or eliminating threats to D. cornutissima as well as updated information on the species distribution, biology, and management needs (USFWS, 2008).
- Support further research on A. The effects of prescribed burning and other management tools on D. cornutissima. Continue working with public land managers to increase management efforts to benefit D. cornutissima on their sites. B. Additional life history needs. Additional information is needed on how cogon grass and other invasive plants affect D. cornutissima plants and what the effects of the herbicides used to eradicate cogon grass have on this species. C. The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitat. D. The various pollinators (e.g. Hymenoptera and Lepidoptera), as well as how different ant species assist with seed

dispersal (USFWS, 2008).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2008).
- Complete a rangewide survey to find all known and potential sites occupied by D. cornutissima and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2008).
- Consider reintroduction and monitoring of D. cornutissima on additional publicly owned lands with suitable habitat. Reintroduction of D. cornutissima could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence wherever additional opportunities present themselves. • Encourage landowners whose populations are under a habitat management plan to monitor occupied habitat for increased data of long-term trends. • Engage Duke Energy Corporation to encourage routine powerline vegetation maintenance activities to benefit species through seasonal timing and education (USFWS, 2023).

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# SPECIES ACCOUNT: *Dicerandra frutescens* (Scrub mint)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/2/1985; Southeast Region (R4)

**Physical Description**

The scrub mint is a dense or straggly, low-growing shrub (Kral, 1983). It reaches 50 cm in height and grows from a deep, stout, spreading-branching taproot. Its branches are mostly spreading, and sometimes are prostrate. Its shoots have two forms, one which is strictly leafy and overwintering, and another which is flowering and dies back after fruiting. The leaves vary in shape. They can be narrowly oblongelliptic, linear-elliptic, or linear-oblanceolate (Kral 1983). The upper surface of the leaves is dark green, with the midrib slightly impressed. The lower surface is slightly paler, with the midrib slightly raised. They are 1.5 to 2.5 cm long, 2 to 3 mm wide, subsessile, flattish but somewhat fleshy, narrowly or broadly rounded at the apical end, have entire margins, and are not revolute. Scrub mint has an inflorescence that is elongated and interrupted, and, at least half of the flowering shoot is floriferous (Kral 1983). The calyx, at anthesis, is approximately 9 to 10 mm long, nearly erect, proximally and medially green, and distally tinged with red, with a broad white zone around the orifice. The corolla is 1.9 to 2.0 cm long, with an erect tube that is approximately 7 mm long. The external surface of the throat and limb is white or yellowish white. The upper lip is marked internally with a trellis pattern of lines and dots of deep purple, while the lower lip is maculate with larger, concentric spots from lobe bases to base of the lip. The flower has two pairs of stamens, with one pair slightly longer than the other (Kral 1983). The filaments are white, and the anthers are purple. Styles are almost white and bent forward or curved downward (usually above the anthers). (USFWS, 1999)

**Taxonomy**

Dicerandra frutescens was named by Lloyd Shinners (1962); his circumscription of the species was modified by Huck (1981), who reassigned specimens from Sumter and Marion counties to a new species, Dicerandra cornutissima. Kral (1982), working independently of Huck, came to the same conclusion. (USFWS, 1999)

**Historical Range**

Historically distributed more or less contiguously along a high yellow-sand ridge that has only been fragmented within the last 40 to 60 years (Menges et al. 2001). (USFWS, 2009)

**Current Range**

Dicerandra frutescens is endemic to a very limited portion of the Lake Wales Ridge in Highlands County, Florida, and is found at four localities. The mint occurs at Archbold Biological Station; in the Sun 'n' Lakes Estates subdivision east of US highway 27 and southeast of the town of Lake Placid; at YMCA Camp Florida on the west side of Grassy Lake southeast of the town of Lake Placid; and on a sand ridge along the northwest shore of Lake Placid. All four of these areas are native vegetation which are surrounded by agricultural and residential areas. (NatureServe, 2015. )

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexually, with outcrossing (USFWS, 1999)

**Dependency on Other Individuals or Species**

Adult: Needs insects for pollination (USFWS, 1999)

**Other Reproductive Information**

Adult: Scrub mint is insect pollinated and requires insect visits for seed production (Evans et al. 2004). Exprosopa fasciata (Diptera: Bombyliidae), a bee-fly is the dominant pollinator, accounting for 95 percent of all visits at Archbold Biological Station (ABS) . (USFWS, 2019).

**Reproduction Narrative**

Adult: Dicerandra frutescens has perfect flowers (Kral 1983) and reproduces sexually, with outcrossing (Huck 1981). It is not capable of spreading clonally (Menges 1992), but has been shown to root easily from cuttings of vegetative growth (FWS 1987). Growth containing flowers or flower buds will also root, but will often flower then die (FWS 1987). Its flowers have spurred anthers, which require triggering by insects to release and disperse pollen (FWS 1987). Though visited by a variety of insects (Huck et al. 1989), the scrub mint is pollinated mainly by bee-flies (Menges 1992). Its flowering occurs from August through winter, and fruit production occurs from September through winter (Wunderlin 1984). (USFWS, 1999)

**Habitat Type**

Adult: Scrub vegetation

**Environmental Specificity**

Adult: Dicerandra frutescens is a gap-utilizing species; it inhabits open areas in the vegetation. It does not tolerate shading by other plants. (USFWS, 1999)

**Habitat Narrative**

Adult: Dicerandra frutescens is mostly restricted to excessively drained, yellow sandy soils of the Astatula and Paola soil types (Menges 1992). However, it has been found on a moderately well-drained, yellow sand of the Orsino type (Menges 1992). In these soil types, scrub mint occurs adjacent to or within disturbed areas in sand pine scrub, oak scrub and sandhill habitats (FWS 1987, Menges 1992). It occupies sites with shallow litter layers that have an incomplete, or non-existent, tree and shrub canopy (Menges 1992). (USFWS, 1999)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: The scrub mint's seed dissemination mechanisms are unknown, though they possibly include passive dispersal (E. Menges, Archbold Biological Station, personal communication 1997). It is possible that the seeds are not dispersed far from the parent plant, since seed dispersal in the related Lakela's mint (Dicerandra immaculata) is known to be very limited. Observations of an introduced population of Lakela's mint at Hobe Sound NWR indicate that the seedlings occur a maximum distance of 2 m from parent plants (Race 1994). Scrub mint's seeds survive in the seed bank for at least 2 years (E. Menges, Archbold Biological Station, personal communication 1997), and if dispersal in scrub mint is similarly limited, then persistence in the seed bank may be an important strategy that this species uses for colonizing newly disturbed areas. (USFWS, 1999)

***Population Information and Trends***

**Number of Populations:**
14

**Population Size:**
~5,000

**Population Narrative:**
In the most recent FNAI Element Tracking Summary (FNAI 2015), scrub mint was known from 14 occurrences, 7 of which were on managed areas. The other seven occurrences were located on private land and their status was unknown. Based on 2008 aerial images, it appeared that four occurrences were likely extirpated or heavily disturbed and another five were possibly still extant based on remaining habitat in the area where they were previously recorded. Scrub mint populations are dependent on fire for long-term persistence (Menges et al. 2006). There is an inverse relationship between time-since-fire and multiple demographic and reproductive factors, including mortality of adult plants, growth and maturation rates, plant fecundity, number of pollinator visits, and seedling recruitment. Populations begin to decline six years after a fire (Menges et al. 2006; Evans et al. 2008). A population viability analysis (PVA) indicated that population growth rates decline below the replacement level of 1.0 (on average) in populations that remain unburned more than five years (Menges et al. 2006). Most demographic parameters peak at 3 to 5 years post-fire, after which populations experience a long, slow decline (Menges and Weekley 1999). Stochastic simulations using both regular and stochastic fire regimes predicted that fire return intervals of 6 to 12 and 6 to 21 years, respectively, were optimal for minimizing extinction risk. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land

uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

**Stressor:** Drought
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drought exacerbates declines due to lack of fire and prevents strong post-fire recovery of scrub mint populations. Regeneration of populations from seed after fire appears to be lower due to reduced seedling survival when a ‘dry’ year follows a fire. At ABS, a burn in 2006

was followed by a drought period and did not result in a strong population recovery as observed following other fire events. Since 2005, the scrub mint populations at ABS have been declining. Few seedlings were recruited in 2006 and 2007 (E. Menges pers. comm. 2008). Although 188 seedlings recruited early in 2008, less than half (48.4 percent) survived the spring drought (C. Weekley, pers. comm. 2008). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of D. frutescens, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the seral stage of xeric oak scrub that supports D. frutescens (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support populations of sufficient sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution of D. frutescens. Conduct surveys of D. frutescens. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Continue research on life history characteristics of D. frutescens. Although recent work on D. frutescens can be used to infer answers to some life history questions, much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)

- Monitor existing and reintroduced populations of D. frutescens. (USFWS, 1999)
- Provide public information about D. frutescens. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of D. frutescens. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. frutescens and other rare species require a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine the condition of the unprotected occurrences on private land whose status is currently unknown. • Acquire or secure permanent easements on lands with existing populations from willing sellers and restore scrub habitat on these sites, including the implementation of prescribed fire and vegetation thinning by hand. • Advocate for and support the application of prescribed fire to maintain xeric scrub habitat for scrub mint. • Advocate for and support the use of small-scale, hand removal of woody shrubs and tree species around scrub mint populations either in combination with or independent of prescribed fire. • Conduct a taxonomic study of the Dicerandra genus within Central Florida using a multidata approach (e.g., morphology, genetics, geography, ecological factors, etc.). • Continue demographic monitoring and expand to additional occurrences, especially those that are protected. • Evaluate and strengthen ex situ efforts for scrub mint. • Service recovery leads should maintain open lines of communication with State land managers and provide updates as appropriate to ensure proper management of occurrences. (USFWS, 2021)

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# SPECIES ACCOUNT: *Dicerandra immaculata* (Lakela's mint)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Lakela's mint is a small, fragrant shrub that can be differentiated from other Dicerandra by its spotless, lavender-rose colored flower. Lakela's mint reaches 20 inches (in) tall (Kral 1982). Its growth is bushy when in open sun but becomes lax when in shade. It forms small mats or domes of ascending to spreading or sprawling branches. The primary branches arise from a stout, deep, woody-branched taproot, and its numerous innovations arise from spreading or sprawling older growth. The main leaves are spreading (horizontal) or ascending (pointing upward), while those in the inflorescence (flower cluster) are sometimes reflexed (pointing downward) (Kral 1982). All leaves are linear, oblong-linear, linear-elliptic, linear-lanceolate or linear-oblanceolate in shape. They are 0.75–1.2 in long, 0.08-0.16 in wide, smooth, flattened, subsessile, narrowly rounded at the apical end, often slightly emarginate, and entire, though larger leaves can be minutely serrulate at the apical end. The inflorescence is usually 6-10 in long (Kral 1982). Its flowering cymes overlap and each has one, three, or five flowers. The calyx body is 0.28-0.31 in long and is usually purplish, becoming white or roseate toward the orifice. The corolla is about 0.75 in long, immaculate (not spotted), and is a bright lavender-rose. The upper corolla lip is broadly ovate to obovate, about 0.28 in long, apically upswept, and broadly rounded-emarginate. The lower lip is broadly obovate, trilobate, 0.35-0.40 in long, and downswept. The lateral lobes are spreading, oblong, broadly rounded, or oblique-truncate, and the medial lobe is emarginate. The anthers are exserted, and the style is projecting. (USFWS, 2016)

**Taxonomy**

The color of the corolla, lavender-rose to purplish, and its lack of spots separate Lakela's mint from other species of the Dicerandra genus (Service 1985). A new variety, D. immaculata Lakela var. savannarum, was described from southern St. Lucie County and is separated from D. immaculata var. immaculata by its wider leaves and lax habit (Huck 2001). With the original description of Dicerandra immaculata (Lakela 1963), Lakela briefly described and named a white-flowered form she found in the populations. She named this form D. immaculata forma nivea Lakela. In accordance with 50 CFR Subpart B, section 17.12(g), when we listed Lakela's mint as an endangered species, all lower taxonomic units were considered included as the listed entity. Thus the taxon D. immaculata forma nivea was treated as endangered at the time of listing. Although described as a different, but still lower taxonomic rank than species, the same endangered status applies to the more recently described D. immaculata var. savannarum. (USFWS, 2016)

**Historical Range**

The historic range of Lakela's mint is extremely small, encompassing an area only one-half mile wide by three miles long in southern Indian River and northern St. Lucie Counties (USFWS,1999).

**Current Range**

The current range of Lakela's mint is limited to St. Lucie and southern Indian River Counties in Florida, with an additional introduced site in Martin County. (USFWS, 2008)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Seedling recruitment occurs primarily from December through March but can occur at any time of the year (Peterson et al. 2009). Leafing occurs from February to August. Anthesis occurs primarily from September to November and sporadically throughout the year. Fruiting occurs primarily from October to December and sporadically throughout the year (Austin et al. 1980). Mortality rates increase during September through December (Peterson et al. 2009). Plants appear to become reproductive at 1 to 2 years of age (Peterson et al. 2009). However, Lakela's mint has very low germination rates and germination is inconsistent (Peterson et al. 2009). Experimental germination trials seem to indicate that fire may increase germination success (Peterson et al. 2007); however, Huck (in litt. 2008) cautioned that fire does not trigger germination and should be used with care. Lakela's mint only reproduces through seeding and needs insects for pollination. Its flowers have spurred anthers, which require triggering by insect vectors to release and disperse pollen (Service 1987). Not all of the insect species responsible for the pollination of this mint are known, but it is thought that bees may pollinate the plants (Huck 1987). Seed dispersal of Lakela's mint is limited. Introduced colonies at the Hobe Sound National Wildlife Refuge (NWR) have dispersed no more than 6.5 feet from parent plants (Race 1994). In addition, Austin et al. (1980) indicated that areas of disturbed sandy soils within the vicinity of Lakela's mint colonies provided no evidence of recolonization. Oliveira et al. (2007) indicated that closely related taxa occur in close physical proximity to one another, which supports seed dispersal hypotheses; there is a lack of long-distance seed dispersal except by intermittent rainfall events that transported fruits along waterways, by high winds from hurricanes, or by the rise and fall of sea level during the Pleistocene as new habitat formed (Huck and Chambers 1997, Oliveira et al. 2007). It is interesting to note that all of the perennial taxa, including Lakela's mint, have very narrow geographic distributions, whereas the annuals are more widely distributed and none are listed or considered rare.

**Habitat Type**

Adult: Scrub

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Lakela's mint is found in light shade or clearings in scrub in a limited area along the Atlantic coastal ridge in south Florida (Service 1987). Lakela's mint is a "gap" species. It abounds in open sunlight, but becomes straggly and weak as woody plants and saw palmetto invade open areas (Kral 1982). It occupies sites with varying degrees of litter, from partly covered to bare sand. These bare sands are probably created through a combination of wind action and fires. The mint has been observed growing on both white and yellow sands of the following soil series: Astatula sands, Paola sands, and St. Lucie sands (Service 1985). These soils are deep, nearly level to sloping, occur on high, dune-like ridges, and are acidic. Intensive site maintenance, including removal of vines, invasive species, grass competitors, and small trees and limbs that over-shade the plants, improves habitat conditions and provides additional capacity to support more individuals (Peterson et al. 2007). However, if not managed as such, overgrowth of the habitat reduces the amount of sunlight available and increases competition from other plants for nutrients and light, rendering long-term proliferation of the species unlikely without fire or other disturbance. Habitat conditions in and around the existing populations of D. immaculata var. savannarum also continue to deteriorate, resulting in population decline (Barry et al. 2007).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2008)

**Number of Populations:**

14 (5 natural and 9 introduced) (USFWS, 2021)

**Population Size:**

6,100 - 9,660

**Adaptability:**

Very sensitive to disturbance and successional canopy closure. (NatureServe, 2015)

**Population Narrative:**

Like other Dicerandra species, Lakela's mint is protected from insect herbivory by its essential oils (McCormick et al. 1993). Likewise, the variety savannarum also has essential oils, although it contains three compounds that are not present in Lakela's mint (Peterson et al. 2009). The cut leaves of one of its relatives, scrub mint (Dicerandra frutescens), have been shown to repel ants, and only Pyralid moths are known to feed on it (Eisner et al. 1990). Whether Lakela's mint is protected to this degree has not been verified. Though resistant to insect feeding, Lakela's mint populations have been adversely affected by mildew. Mildew grows on the nectary glands and can cause destruction of the fruits, destroying the viability of seeds before dispersal (Austin et al. 1980, Robinson 1981). Because of urban development, the overall distribution of Lakela's mint is significantly reduced. Trends in spatial distribution show increasing fragmentation of Lakela's mint as the coastal ridge has become developed and fire has been suppressed. Spatial distribution of Lakela's mint may be affected by disturbance factors. All Dicerandra mints, including Lakela's mint, in the southeastern United States tend to grow on disturbed sites, such as eroded dunes, sides of scraped dirt roads, fire lanes, unsodded banks, drainage ditches with loose sand, steep river banks, and gopher tortoise holes (Huck 1987, Huck in litt. 2008). On the Hallstrom Farmstead, plants are generally clustered in two areas on the property at tree-line edges next to sand paths or sandy openings (Peterson 2007a). The Service has observed that the distribution of the other remaining large natural population is similar. During fall 2006, 29 private properties in coastal scrub within the vicinity of the Hallstrom Farmstead and south to Indrio Road were surveyed (Peterson 2007b, Peterson et al. 2007). Only one new mint site was identified from this effort, and it contained approximately 10 plants (Peterson et al. 2007). It is presumed that this colony is part of one of the originally identified Florida Natural Areas Inventory sites (Peterson 2007b, Peterson et al. 2007). Additionally, two other sites containing the mint were brought to our attention (Peterson 2007b, Peterson et al. 2007). These small colonies were estimated to each contain 15-50 individual plants (Peterson 2006). All of these new sites are at risk of being developed and rescue efforts to obtain and preserve genetic material have taken place. At least one of the sites has already been cleared for development (Peterson et al. 2007). The population where it is believed that Dr. O. Lakela first collected the original type specimen for the species 45 years ago has disappeared (Huck in litt. 2008). Additionally, 53 private parcels encompassing over 100 acres along the Atlantic coastal ridge from Midway Road south to County Line Road in St. Lucie County and additional areas in Martin County south to Sewall's Point were surveyed to determine if the variety occurs in other locations, but no new populations were observed (Barry et al. 2007). At least seven sites where Lakela's mint occurred have been extirpated, including one that contained the new variety. In total, there are seven extant sites where populations naturally occur and four introduced populations. However, two of the sites where they occur naturally are slated to be developed. Four of the natural sites are privately-owned and three are on public lands. The four introduced populations (two populations of Lakela's mint and two of the new variety) are all on public lands. Trend data indicate declines in populations of both Lakela's mint and the variety savannarum. The total population of Lakela's mint is estimated to be between 6,100 and 9,660 plants (Peterson et al. 2009). When first discovered in 1995, approximately 200 individuals of the new variety were counted (Huck 2001). Due to drought and over-shading from competing plants, the natural population steadily declined to 89 individuals in 2005 and to nearly zero plants in 2012 (Peterson and Richardson in press). Lakela's mint occupies open areas in scrub, so prescribed burning or equivalent management is necessary to maintain the quality of its habitat. The way this species responds to disturbance and the frequency of disturbance needed are not known. Lakela's mint is a narrow ranging species, historically occurring in just two Florida counties along the Atlantic Coastal Ridge (southern St. Lucie and northern Indian River Counties). Introductions in Martin County and northern Indian River County have increased the species' range from approximately 3 to 59 mi (4.8 to 95 km) long. In 1996, the Savannas mint variety was discovered in southern St. Lucie County (Huck 2001). Introductions of this variety have increased its range from approximately 0.5 to 4 mi (0.8 to 6.4 km) long. There are currently 14 populations (5 natural and 9 introduced) of Lakela's and Savannas mint (Table 1; Peterson et al. 2009; Peterson 2017a, 2018, 2019, 2020, 2021a, 2021b, 2021c; Eastwick 2020). Since the previous status review (Service 2008), three populations have been introduced (one Lakela's mint and two Savannas mint) (Table 1; Peterson 2017a, 2020). However, the last remaining natural population of Savannas mint has been extirpated, portions of two Lakela's mint populations on private sites have been extirpated, and two populations of Lakela's mint entirely on private property are in danger of development and currently for sale (Table 1; Peterson et al. 2009; Peterson 2018, 2019, 2020; Service biologist observations 2020, 2021). Despite recovery efforts and the increase in number of introduced populations, only a few of the Lakela's mint populations are large enough to withstand stochastic events (Service 2019a), and even large populations are observed to decline rapidly in unsuitable habitat and weather conditions (Peterson et al. 2009; Peterson 2020). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2008)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Continued habitat loss, fragmentation, and changes in land use threaten the existence of Lakela's mint. Although a few populations are on sites that are publicly owned, populations on private sites are threatened with destruction or habitat modification due to improper or lack of management.-Just since July 2006, HBS has rescued plants from two sites slated for development that were identified as a result of the survey effort from the Hallstrom Farmstead south to Indrio Road, one containing 2 plants and the other containing 56 (Peterson et al. 2007). The germplasm waSTI) aced in the National Collection, but the sites where these plants naturally occurred have now been lost. One of these sites was near the Hallstrom Farmstead, but because recent surveys in the surrounding area have yielded no positive results it is presumed that all adjacent colonies have been lost to development (Peterson et al. 2007). - Two additional plant rescues have been initiated since July 2006, and HBS is in the process of tagging and removing seeds and cuttings from all individuals on the sites with the hope of removing as many adult plants as possible (Peterson et al. 2007). One site containing 50-100 plants will be cleared to become a retention pond as part of a road project, and a bridge and development will be built through the other property that contained over 500 healthy plants and seedlings (Peterson et al. 2007). The only two locations where the variety is known to occur naturally are on private lands and both are threatened with destruction as a result of lack of management, dumping, or development (Peterson et al. 2007). Because of these threats, some of the plants were rescued, propagated, and introduced onto protected land in 2005, and germplasm was placed in the National Collection for preservation of genetic material (Peterson et al. 2007). However, it is probable that both of these natural populations will be extirpated. - Between 2005 and 2060 Florida's population is projected to double from approximately 18 to 36 million people (Zwick and Can 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). It is projected that the coastal counties of Florida will be almost entirely built out by 2060 (Zwick and Carr 2006). Within the range of Lakela's mint, the model predicts that the human population will grow from just below 130,000 to nearly 285,000 in Indian River County and from 232,000 to over 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Can 2006). Therefore, habitat loss, degradation, and fragmentation continue to threaten the species. (USFWS, 2008)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Generally, managing agencies have limited regulatory tools. The Act provides protection for this species and its habitat through section 7 (interagency cooperation). Lakela's mint is also listed by FDACS as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with mints have been developed, and the only option for the plants was to rescue them prior to clearing. Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable

real estate for development due to its elevation, this species remains vulnerable where it occurs on private property. (USFWS, 2008)

**Stressor:** Land management practices (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Land management practices such as canopy reduction are vitally important to maintaining and working towards recovery of Lakela's mint. Even though some sites are protected from development, habitat degradation may still be a concern at these sites. This species occurs in scrub habitat along the Atlantic coastal ridge, which is typically maintained by fire (Peterson 2007b). On many privately owned scrub sites, fire has historically been suppressed, and habitat has not received regular maintenance. If sites are not regularly maintained, vines tend to overtake the mints, competition for light, water, and nutrients from grasses and invasive species becomes too great, and limbs and small trees limit the amount of available sunlight necessary for survival (Peterson 2007b). Invasive plant species that impact the mints include, but are not limited to, Brazilian pepper (Schinus terehinthifolius), rosary pea (Abrus precatorius), natal grass (Rhynchelytrum repens), and guinea grass (Panicum maximum). (USFWS, 2008)

**Stressor:** Other natural or manmade factors (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management on protected lands remains an imminent, though moderate, threat. Degradation to habitat can also occur from damage by feral hogs (Sus scrofa), as cited in recent reports that assessed three Florida state parks (Engeman et al. 2003, 2004). Also, the species' limited distribution renders it vulnerable to random natural events, such as hurricanes and drought. (USFWS, 2008)

***Recovery***

**Reclassification Criteria:**
Not defined. (USFWS, 1999; USFWS, 2019)

Recovery Priority Number: 2C

**Delisting Criteria:**
1. When at least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)

2. When populations (as defined in criterion 1) in coastal sand pine scrub habitat are distributed across the historical range of the species in order to maintain and enhance the species geographic patterns of genetic diversity. (Factor A) (USFWS, 2019)

3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, D, E). (USFWS, 2019)

**Recovery Actions:**

- 1. Determine current distribution of D. immaculata. A comprehensive survey of D. Immaculata's range was completed in fall 1996. Taxonomic questions still exist with a newly located population at the Martin County border that make a definitive distribution difficult. (USFS, 1999)
- 2. Protect and enhance existing populations. Much of the native xeric uplands on the Atlantic coastal ridge has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- 3. Conduct research on life history characteristics of D. immaculata. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- 4. Monitor existing populations of D. immaculata. Develop monitoring protocol to assess population trends for D. immaculata. Develop a quantitative description of the population structure of D. immaculata. Monitor re-introduced plants. (USFWS, 1999)
- 5. Provide public information about D. immaculata. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society,and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of D. immaculata. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. immaculata and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Both urbanization and fire suppression have decreased the available habitat. To date, there are no protected sites for this species in its historic range. - Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. - Conduct habitat-level research projects. Study the response of D. immaculata to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. - Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, etc., on the habitats where D. immaculata occurs. - Provide public information about xeric vegetative communities and its unique biota. (USFWS, 1999)
- Continue to survey potential habitat and pursue conservation agreements/implement management recommendations and/or acquire land. This is a high priority action, particularly for D. immaculata var. savannarum. • Include D. immaculata var. savannarum in conservation programs to conserve the genetic diversity found in the entire genus (Oliveira et al. 2007) • Write a management plan after acquisition of the portion of property containing the Lakela's mint at the HBOI property. (USFWS, 2008)
- Identify additional reintroduction sites and establish reintroduced populations; population augmentations should also be implemented. • Continue monitoring for both reintroduced and natural populations. • Propagation efforts should continue and clones of the original

"parent" should be placed throughout the Halistrom site to augment the population. • Where private sites are being developed, efforts should be continued to rescue individual plants and use them for propagation or to augment populations on protected sites. (USFWS, 2008)

- Federal, state, and local agencies, botanical gardens, and conservation organizations should convene to evaluate the current status of protection and the level of implementation of management practices at each site and to discuss current levels of support, threats to habitat and individual plants, and any obstacles to management and recovery. (USFWS, 2008)
- Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2008)
- To re-create open soils, managers should consider implementing mechanical disturbance, such as scratching or raking around plants, removing competitive plants in the vicinity of mints, or lightly disking larger areas, after mints flower but before the fruits drop (approximately two months after blooming) (Huck in litt. 2008). • Work with staff at Savannas Preserve State Park to understand habitat requirements of this species. • Conduct research on the response of Lakela's mint to fire and fire prescriptions necessary to benefit the species. • Continue seed germination studies and make efforts to develop additional outplanting techniques, especially those that may alleviate dessication of plants during dry conditions. • Demographic studies such as long-term survival and potential correlations with rainfall cycles and other variables should be examined. (USFWS, 2008)
- Opportunities should be sought where possible to include the media in the first Hallstrom Farmstead augmentation to provide information about this species to the public. • Conduct additional research on the biology, ecology, genetics, and management needs of the species. (USFWS, 2008)
- Partnerships should be promoted to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Continue management actions to include removal of debris and exotics, canopy and vine reduction, controlling public access, re-creation of open areas and loose sands, and the careful reintroduction of prescribed fire into the ecosystem. (USFWS, 2008)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Increase land management actions to include removal of hardwoods, debris and exotics, canopy and vine reduction, and reintroduction of prescribed fire into the ecosystem. • Conduct research on the response of Lakela's and Savannas mint to fire and fire prescriptions necessary to benefit the species. • Collaborate with partners and stakeholders on development of long-term habitat improvement and maintenance plans specific to the mints on public lands. • Develop a long-term, regular monitoring program for both reintroduced and natural populations. • Continue long-term spatial seedling recruitment and survival research. • Continue seed predation studies to determine if seed predators are a significant threat to the survival of the species. • Perform further research on pollinator species significance in the recovery and survival of Lakela's mint and Savannas mint. Explore potential connection between lack of pollination to seeds found with fungus. • Continue propagation efforts; clones of the original "parent" should be placed throughout the Hallstrom site to augment the population. • Continue seed germination studies and make efforts to develop additional outplanting techniques, especially those that may alleviate desiccation of plants during dry conditions. • Perform demographic studies such as long-term survival and potential correlations with rainfall cycles and other climate variables. • Continue to survey potential habitat and pursue conservation agreements, implement management recommendations, and/or acquire land, particularly for D. immaculata var. savannarum (Savannas mint). • Increase outreach efforts to raise awareness of this native species and the natural scrub habitat. • Promote partnerships to share information, seek funding, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Identify additional reintroduction sites and establish reintroduced populations; implement population augmentations. • Where private sites are being developed, efforts should be continued to rescue individual plants and use them for propagation or to augment populations on protected sites. • Conduct additional research on the biology, ecology, genetics, and management needs of the species. • Conduct a taxonomic study of the Dicerandra genus within Central Florida using a multidata approach (e.g., morphology, genetics, geography, ecological factors, etc.). (USFWS, 2021)

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# SPECIES ACCOUNT: *Diplacus vandenbergensis (=Mimulus fremontii var. v.)* (Vandenberg monkeyflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 9/25/2014; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

Vandenberg monkeyflower is a small, annual herbaceous plant that grows from 0.5 to 10 inches (in) (1.2 to 25.4 centimeters (cm)) tall. The stems are glandular and usually green with purplish tinting. Leaves are obovate (narrowly elliptic) and reach 1.2 in (3 cm) in length. Plants produce a single flower or plants are branched producing multiple flowers. The tubular yellow flowers are bilaterally symmetrical, with the distal ends of the petals forming a unique structure that is likened to a face; hence the common name monkeyflower. Seed capsules are ovoid and reach 0.5 in (1.3 cm) in length. The capsule splits open longitudinally from the tip to release approximately 20 to 100 seeds. (USFWS, 2013)

**Taxonomy**

Vandenberg monkeyflower was first described as Mimulus fremontii (Benth.) A. Gray var. vandenbergensis D.M. Thompson (Thompson 2005, p. 134) as a member of the Scrophulariaceae (figwort family). This is the name and family placement we have previously followed. Molecular systematics studies examining members of the Scrophulariaceae, including Mimulus, determined that this genus and a few others constituted a separate monophyletic group warranting recognition at the family rank as Phrymaceae (Beardsley and Olmstead 2002, pp. 1193-1101; Olmstead 2002, p. 18). Placement of Mimulus in the family Phrymaceae is recognized by species experts, is used in the recent flora of California (Thompson 2012, pp. 988-998), and will be treated as such in the upcoming volume of the Flora of North America. In 2012, Barker et al. (2012) recognized a redefined genus Diplacus that includes 46 taxa previously segregated as Mimulus, including Vandenberg monkeyflower as Diplacus vandenbergensis (D.M. Thompson) Nesom (Barker et al. 2012, p. 29). The citation in Barker et al. (2012, p. 29) attributes the nomenclatural combination at the species rank to Nesom in Phytoneuron 2012-47: 2, which was published electronically on the same day as Barker et al. (2012). The Start Printed Page 64842current citation for Vandenberg monkeyflower is at the species rank as Diplacus vandenbergensis (D.M. Thompson) G.L. Nesom. This combination is accepted by species and genus experts and will be used in the upcoming treatment in the Flora of North America. Accordingly, we will use the correct name (Diplacus vandenbergensis) and family attribution (Phrymaceae) throughout this and subsequent documents. (USFWS, 2013)

**Historical Range**

Historical locations for Vandenberg monkeyflower are known from Santa Rita Valley, Lower Pine Canyon, Lower Santa Lucia Canyon in Santa Barbara County, California. (USFWS, 2013)

**Current Range**

Endemic to the eastern portion of Burton Mesa (Wilken 2010 in Elvin 2010) in Santa Barbara County, California. Mimulus fremontii var. vandenbergensis is bounded by Purisima Hills to the north and east, Santa Ynez River to the south, and the mesa edge on the west side of Santa Lucia Canyon, including the tributary canyons to the west (e.g., Lakes, Oak, and Pine Canyons).

The habitat and soils that it grows on are only found in a crescent-shaped area approximately 10.7 km long by 3.0 km wide that comprises less than 6,070 ha or 60.7 square km (Elvin 2010). (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 9/10/2015.

**Legal Description**

On August 11, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 10, 2015) for Diplacus vandenbergensis (Vandenberg monkeyflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (80 FR 48142-48170).

**Critical Habitat Designation**

The critical habitat designation for Diplacus vandenbergensis includes four CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 5,755 acres (ac) (2,329 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 48142-48170).

Unit 1: Vandenberg: Unit 1 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 223 ac (90 ha). Unit 1 is located adjacent to and between two extant occurrences (Oak Canyon and Pine Canyon, which are located on Vandenberg AFB) and is known to support suitable habitat for Vandenberg monkeyflower.

Unit 2: Santa Lucia: Unit 2 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing, is currently occupied by the species, and consists of 1,484 ac (601 ha). This unit includes State lands (96 percent) within the Reserve, relatively small portions of local agency lands (for example, school districts, water districts, community services districts) (less than 1 percent) and private lands (3 percent). Unit 2 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. The eastern boundary of Vandenberg AFB delineates the western boundary of this unit. Unit 2 includes most of the Vandenberg and Santa Lucia Management Units of the Reserve. Unit 2 extends from Purisima Hills at the northern extent through the width of Burton Mesa to the agricultural lands south of the Reserve, and to the eastern boundary of the Vandenberg and Santa Lucia Management Units where these units abut Vandenberg Village.

Unit 3: Encina: Unit 3 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 2,024 ac (819 ha). This unit contains State-owned lands (72 percent), including most of the Encina Management Unit of the Reserve, local agency lands (1.2 percent), and privately owned lands such as areas adjacent to the Clubhouse Estates residential development (27 percent) (see Table 1 above). Unit 3 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. Unit 3 extends from approximately the Purisima Hills to the north, through the Reserve and to the agricultural lands just south of the Reserve boundary, and is between Vandenberg Village and State Route 1 to the east and the residential communities of Mesa Oaks and Mission Hills to the west.

Unit 4: La Purisima: Unit 4 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 2,024 ac (819 ha). Unit 4 contains mostly State-owned lands (89 percent) consisting of most of La Purisima Mission SHP and a small portion of the La Purisima Management Unit of the Reserve that is north of La Purisima Mission SHP. This unit also contains private land to the east of La Purisima Mission SHP (11 percent), and a small portion of local agency lands (less than 1 percent) (see Table 1 above). Unit 4 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. This unit extends approximately from the Purisima Hills in the north to the southern boundary of La Purisima Mission SHP, and between the residential communities of Mesa Oaks and Mission Hills to the west and to just east of, and outside, the State Park’s eastern boundary.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Diplacus vandenbergensis critical habitat consists of two components (80 FR 48142-48170):

(i) Native maritime chaparral communities of Burton Mesa comprising maritime chaparral and maritime chaparral mixed with coastal scrub, oak woodland, and small patches of native grasslands. The mosaic structure of the native plant communities (arranged in a mosaic of dominant vegetation and sandy openings (canopy gaps)) may change spatially as a result of succession, and physical processes such as windblown sand and wildfire.

(ii) Loose sandy soils on Burton Mesa. As mapped by the Natural Resources Conservation Service (NRCS), these could include the following soil series: Arnold Sand, Marina Sand, Narlon Sand, Tangair Sand, Botella Loam, Terrace Escarpments, and Gullied Land.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain physical and biological features that are essential to the conservation of the species and that may require special management considerations or protection. All areas proposed as critical habitat will require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Vandenberg monkeyflower. In all areas, special management is needed to ensure that the habitat is able to provide for the growth and reproduction of the species. The habitat where Vandenberg monkeyflower occurs faces threats from urban development, maintenance of existing utility pipelines, anthropogenic fire, unauthorized recreational activities, and most substantially the expansion of invasive, nonnative plants (see Factors A and E in the proposed listing rule). Management activities that may reduce these threats include, but are not limited to: (1) Protecting from development lands that provide suitable habitat; (2) minimizing habitat fragmentation; (3) minimizing the spread of invasive, nonnative plants; (4) limiting authorized casual recreational use to existing paths and trails (as opposed to off-trail use that can spread invasive species to unaffected areas); (5) controlled burning; and (6) encouraging habitat restoration. These management activities would limit the impact to the physical or biological features for Vandenberg monkeyflower by decreasing the direct loss of habitat, maintaining the appropriate vegetation structure that provides the sandy openings that are necessary components of Vandenberg monkeyflower habitat, and minimizing invasive, nonnative plants spreading to areas where they currently do not exist. Preserving large areas of contiguous suitable habitat throughout the range of the species should maintain the mosaic structure of the Burton Mesa chaparral that may be present at any given time, and maintain the genetic and demographic diversity of Vandenberg monkeyflower. (USFWS, 2013)

***Life History***

**Food/Nutrient Resources**

**Competition**

Adult: Veldt grass, eucalyptus, and pine groves (USFWS, 2015)

**Food/Nutrient Narrative**

Adult: The Vandenberg monkeyflower competes with non-native species such as veldt grass, eucalyptus, and pine groves (USFWS, 2015)

**Reproductive Strategy**

Adult: Mixed mating (USFWS, 2015); seed-banking annual (NatureServe, 2015)

**Lifespan**

Adult: One year (inferred from USFWS, 2015)

**Dependency on Other Individuals or Species**

Adult: Pollinators to achieve seed production; namely smaller solitary bees to medium and larger social bees (USFWS, 2015)

**Reproduction Narrative**

Adult: The Vandenberg monkeyflower is a seed-banking annual plant (NatureServe, 2015). It reproduces with a "mixed mating" strategy and, as an annual plant, lives no more than one year. It is dependent on pollinators to achieve seed production, particularly small to large-sized bees (USFWS, 2015).

**Habitat Type**

Adult: Coastal scrub, chaparral, and woodlands (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevation 30-122 m; restricted to the Burton Mesa region (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Moderately sparse (inferred from USFWS, 2014). Restricted to the Burton Mesa region is andy openings of coastal scrub, chaparral, and woodlands (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: The Vandenberg Monkeyflower inhabits coastal scrup, chaparal, and woodland areas The species is restricted to the Burton Mesa region in sandy openings of coastal scrub, chaparral, and woodlands from 30-122 m in elevation (Elvin 2010). (NatureServe, 2015). Its spatial arrangement is relatively sparse, and habitat connectivity is named as a key resource needed for habitat (USFWS, 2015). The species is an herbaceous annual plant, endemic to the Burton Mesa landform in southwestern Santa Barbara County, California. It occurs on sandy soils, in openings within the canopy of Burton Mesa maritime chaparral habitat. The species needs contiguous stands of Burton Mesa maritime chaparral habitat, canopy openings within this habitat type, loose sandy soils derived from the Burton Mesa Dune Sheet, insect pollinators, adequate annual precipitation, appropriately timed first seasonal rains, and suitable temperature regimes (USFWS, 2024).

***Dispersal/Migration***

**Dispersal**

Adult: High (inferred from USFWS, 2014)

**Dependency on Other Individuals or Species for Dispersal**

Adult: Small mammals (USFWS, 2015)

**Dispersal/Migration Narrative**

Adult: Seeds are primarily dispersed by gravity, along with wind and water over relatively short distances. Long-distance dispersal of seeds occurs in numerous ways, including vertebrate dispersal (e.g. small mammals, by adhesion or ingestion), wind dispersal of seeds (in updrafts and storms, or by secondary dispersal over the substrate), wind dispersal of plants (tumble-plant dispersal), and water dispersal High dispersal is inferred based on discussion and implied relevancy of the surprisingly long flight distances of its pollinators (USFWS, 2014; USFWS, 2015).

**Additional Life History Information**

Adult: Gravity is also named as a means of dispersal (USFWS, 2015)

***Population Information and Trends***

**Population Trends:**

Declining (NatureServe, 2015)

**Species Trends:**

Not available

**Number of Populations:**

7 (NatureServe, 2015)

**Population Size:**

2,000 total individuals observed in 2006; size may vary considerably year to year (NatureServe, 2015)

**Additional Population-level Information:**

The variety was named in 2005 so it is difficult to assess long term trends (NatureServe, 2015)

**Population Narrative:**

There are 7 known populations of this species. While species level trends are not available, a decline has been observed at the population level. Total population size was 2,000 individuals in 2006 and estimated to be similar in 2009, but acknowledged to likely vary considerably from year to year due to the species' status as a seed-banking annual. One population was destroyed in 2007 while the remaining populations are vulnerable to multiple stressors, notably invasion of non-native species. Long-term trends have been difficult to assess, in part because the variety was named in 2005 (NatureServe, 2015).

***Threats and Stressors***

**Stressor:** Habitat destruction and alteration (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The majority of remaining Burton Mesa chaparral where Vandenberg monkeyflower occurs is within Federal or State-owned lands and is protected from development. Therefore, large-scale future development of remaining Burton Mesa chaparral is not likely to occur and thus is not a significant threat to Vandenberg monkeyflower. However, smaller-scale private property development; access to easements; maintenance of utility, oil, and gas pipelines; fire and fire suppression; and authorized and unauthorized recreational activities may continue to take place throughout Burton Mesa. Some of these activities may occur within Burton Mesa chaparral or adjacent to occurrences of Vandenberg monkeyflower, resulting in the destruction and possible removal of Vandenberg monkeyflower habitat and creating open areas for nonnative plants to invade. Therefore, the direct destruction and alteration of chaparral habitat is likely to continue on a relatively small scale and is thus considered a threat to Vandenberg monkeyflower both currently and in the future. (USFWS, 2014)

**Stressor:** Utility and pipeline maintenance (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Utility and pipeline structures occur within the Burton Mesa Ecological Reserve (Reserve), and access routes through the Reserve service the Plains Exploration and Production Company oil processing plant, which surrounds the La Purisima Management Unit of the Reserve. Additionally, local land use agencies and public works agencies retain other utilities and pipelines, and easements for access. For example, the Vandenberg Village Community Services District has several structures (including water tanks, a water processing plant, wells, and water lines and sewer lines) located within the Reserve (Gevirtz et al. 2007, p. 63). These existing facilities or structures at times require routine maintenance to ensure proper operation. As a result, vehicles and foot traffic could occur at or adjacent to these structures and potentially result in trampling of habitat and other soil surface disturbance, which in turn could result in ground disturbance that removes Burton Mesa chaparral and creates open areas in the vegetation that act as pathways for nonnative plants to expand or invade. There is no indication that ongoing maintenance activities of existing pipelines and utilities have directly impacted Vandenberg monkeyflower habitat. However, utility maintenance actions could result in ground disturbance that removes Burton Mesa chaparral, creating open areas in the vegetation that act as pathways for nonnative plants to invade. (USFWS, 2014)

**Stressor:** Invasive, non-natice species (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive, nonnative plants occur and are expanding throughout the Burton Mesa. More specifically, at least one of the four most problematic invasive plants occurs within or adjacent to suitable habitat at each of the nine extant occurrences of Vandenberg monkeyflower and at one potentially extirpated location. Invasive plants have demonstrated the ability to reduce the diversity of native vegetation and convert the native shrublands into nonnative-dominated vegetation. (USFWS, 2014)

**Stressor:** Anthropogenic fire (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because of the human presence and infrastructure on Burton Mesa, the frequency of human-caused wildfires is likely greater than the frequency of historical fires on the mesa. An increased fire frequency in Burton Mesa chaparral would tend to favor the establishment of nonnative vegetation in open areas at the expense of native vegetation. However, the primary threat to Vandenberg monkeyflower and its habitat from fire is the post-fire expansion of invasive, nonnative plants, regardless of the fire frequency. Because an abundance of nonnative plants already occurs on the mesa, and invasive plants rapidly invade open areas, any fire that occurs within or adjacent to Vandenberg monkeyflower habitat is likely to result in an increase of invasive, nonnative vegetation. Likewise, fire suppression activities that include clearing vegetation in fuel breaks or spreading retardant would increase the likelihood of nonnative species invading suitable Vandenberg monkeyflower habitat, as well as enhance the habitat conditions for invasive species expansion. Additionally, because the presence of invasive, nonnative plants creates a positive feedback mechanism, the greater the percent cover of nonnative vegetation, the more likely fires will occur on Burton Mesa. Based on the information presented in this section, the current threat from anthropogenic fire and associated fire suppression activities to Vandenberg monkeyflower habitat described above is expected to continue into the future. (USFWS, 2014)

**Stressor:** Recreation (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recreation is enumerated among the threats and stressors to this species. Recreational activities that occur throughout Burton Mesa include authorized uses such as hunting, hiking, biking, wildlife observation, and leashed-dog walking. Additionally, off-road vehicle (ORV) use is authorized on Vandenberg AFB (Air Force 2011a, p. 6), but it is not permitted on the Reserve (Gevirtz et al. 2007, p. 70) or La Purisima Mission SHP (California State Parks 1991, p. 109). ORV use and other casual recreational activities may contribute to soil disturbance and increase the potential for invasive, nonnative plants to be introduced and further spread across Burton Mesa, including into locations where Vandenberg monkeyflower and its suitable habitat occurs (USFWS, 2014).

**Stressor:** Climate change (USFWS, 2014)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is enumerated among the threats and stressors to this species. Climate change may have potential impacts on Vandenberg monkeyflower and its habitat, such as increased temperatures and decreased precipitation that would likely reduce suitable habitat. Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s (FR, 2014).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number of 8

1. Annual abundance within at least two populations displays stable1 or increasing trends, based on a minimum of 10 years of data. The two populations include the Vandenberg population, within which there are at least 21 extant occurrences, and one of the other populations (either Burton Mesa or La Purísima), and that population includes at least six extant occurrences. (USFWS< 2024)

2. If either of the two needed populations drops below 75 percent of the established three-year average2 of reproductive individuals (baseline), in any single year, adequate funding and resources are available and supplemental seeding and/or other management endeavors (such as invasive weed abatement) will be implemented as necessary to augment the population and increase reproductive output until the population(s) rise back above 75 percent. (USFWS, 2024)

3. The two necessary populations are effectively managed to ameliorate the species threats, with population trends being the primary evidence that all of its biological needs are being met. Vandenberg monkeyflowers' biological needs are described in the SSA (Service 2022, pg. 20-24). (USFWS, 2024)

4. An ex-situ recovery seed bank (a collection of Vandenberg monkeyflower seed stored in a facility to preserve the species and serve as a backup in the event of catastrophic loss) is established and maintained over time. The recovery seed bank will adequately represent the genetic diversity from at least the two requisite populations, and seed from all known occurrences within each population should be included. Seed collections should be made over multiple years (no fewer than three different years). The primary recovery seed bank will be stored in an institution approved by the Center for Plant Conservation with the capability to test germination as needed to ensure viability, and a secondary, reserve collection will be stored in a long-term storage facility, such as the National Laboratory for Genetic Resources Preservation. (USFWS, 2024)

**Delisting Criteria:**
1. Annual abundance within one additional (for three total) population displays stable or increasing trend based on a minimum of 10 years of data. As with the downlisting criteria, the Vandenberg population supports at least 21 extant occurrences, and the other two populations (Burton Mesa and La Purísima) each support at least six occurrences. (USFWS, 2024)

2. If either of the three needed populations drops below 75 percent of the established three-year average of reproductive individuals, in any single year, adequate funding and resources are available and supplemental seeding and/or other management endeavors (such as invasive weed abatement) will be implemented as necessary to augment the population and increase reproductive output until the population(s) rise back above 75 percent. (USFWS, 2024)

3. The three necessary populations are effectively managed to ameliorate the species threats, with population trends being the primary evidence that all of its biological needs are being met. (USFWS, 2024)

4. The established ex-situ recovery seed bank continues to be maintained over time, and adequately represents the genetic diversity from all three requisite populations, with seed from all known occurrences within each population included. Germination testing occurs as needed to ensure viability. Additional accessions of Vandenberg monkeyflower seed are made periodically, and collections managers conduct bulking activities if necessary to supply seeds for restoration and other outplanting projects. (USFWS, 2024)

**Recovery Actions:**

- The Air Force has an approved Integrated Natural Resources Management Plan (INRMP) on Vandenberg Air Force Base in 2011. Included are the following components: (1) Development. The Air Force is not likely to construct new launch facilities within suitable habitat near human-populated areas, and the future siting of community facilities is expected to occur in a manner that capitalizes on existing infrastructure and circulation systems (Air Force 2009a, p. 32). Thus, no specific conservation measures have been proposed to minimize the threat of development to Vandenberg monkeyflower or its habitat on Base. (2) Utility Maintenance and Miscellaneous Activities. Construction of new facilities is not likely to occur within Vandenberg monkeyflower habitat; however, existing utilities will require periodic maintenance. No specific conservation measures were proposed in the addendum to the INRMP (Air Force 2012). The main objective is to avoid any impacts to habitat, when possible, by either confining the work to existing disturbed areas or rerouting the work to avoid suitable habitat completely, and minimize the impact as much as possible (Air Force 2012, p. 2). For Vandenberg monkeyflower, the Air Force would avoid impacting Burton Mesa chaparral as much as possible if utility maintenance is required in suitable habitat. (3) Invasive, Nonnative Plants. The INRMP (Air Force 2011a) includes an Invasive Plant Species Management Plan that identifies the threat of invasive, nonnative plants on Base, and proposes removal methods to limit further spread and assist in restoration of habitat degraded by invasive species. In most cases, the Air Force would utilize chemical application to manage for invasive plants (Air Force 2011a, p. 43). Although the INRMP identified invasive, nonnative plants as a threat and calls for their removal, it did not identify which nonnative species, and which areas on Base, were a priority for treatment. In the 2012 addendum to their INRMP, the Air Force identifies veldt grass as the most problematic invasive, nonnative plant on Base for Vandenberg monkeyflower. As part of this addendum, the Air Force also identified their 10-year funding program, which included more than $500,000 to treat veldt grass, starting in 2009 and continuing through 2019 (Air Force 2012). While the Air Force does not specify precisely where, when, or how much veldt grass will be treated or removed in specific years, they state that a substantial portion of this effort will focus on areas within the range of Vandenberg monkeyflower (Air Force 2012, p. 1). Through 2012, the Air Force has chemically treated approximately 141 acres (57 ha) of invasive, nonnative plants, mostly treating pampas grass within Burton Mesa chaparral but not near extant Vandenberg monkeyflower occurrences (treatment was to benefit Eriodictyon capitatum (Lompoc yerba santa)). Other invasive, nonnative plants treated included veldt grass, iceplant, Eucalyptus spp. (Eucalyptus), and Pinus spp. (Pine)). Only a small proportion of this chemical removal occurred within Burton Mesa chaparral at two locations where Vandenberg monkeyflower occurs (Lake and Pine Canyons) (Lum in litt. 2013). (4) Fire. For fires that would affect Vandenberg monkeyflower and its habitat, the Air Force developed a GIS layer incorporating all potential suitable habitat areas, which has been made available to fire response crews for use during actual fire events. Multiple conservation measures that address the potential threat of fire are included in the addendum (Air Force 2012, p. 2), including the following: (a) Established roads, both paved and unpaved, would be used to the greatest extent possible as fire lines unless an emergency dictates otherwise. (b) Burned areas would be assessed after a fire for rehabilitation options within 10 days of the area being declared safe for entry. (c) Vandenberg monkeyflower habitat affected by wildfire and rehabilitation projects will be monitored, which would include recommendations for nonnative species control. (d) Following any significant wildfire event within the range of Vandenberg monkeyflower on Base, a Burn Area Emergency Response (BAER) project will be initiated. This generally includes implementation of erosion control, native vegetation restoration, firebreak rehabilitation, and invasive species management. Additionally, the addendum proposes to incorporate portions of Vandenberg monkeyflower habitat in a controlled burn program (Air Force 2012, p. 2). (5) Recreation. No conservation measures have been proposed to address the threat of recreation to Vandenberg monkeyflower. (USFWS, 2013)

- Burton Mesa Ecological Reserve (Reserve): The State Lands Commission signed a 49-year lease of the Burton Mesa Ecological Reserve on January 20, 2000. The purpose of the lease is to manage, operate, and maintain these sovereign lands for the sensitive species and habitats they support . The CDFW developed a management plan for the Reserve that guides management of habitats, species, and programs to achieve the mission of CDFW to protect and enhance wildlife values. Conservation measures are proposed in the management plan, contingent upon available funding and staffing. (1) Development. Because new development would not occur on the Reserve, there are no conservation measures to implement that would minimize this threat to Vandenberg monkeyflower. (2) Utility Maintenance and Miscellaneous Activities. Several public utilities and local governmental agencies provide services to the local community and use the Reserve to accomplish their roles. Within the Reserve, agencies responsible for conducting maintenance activities submit maintenance plans for all scheduled activities to CDFW, who in turn may request conservation measures (such as modifying the size and frequency of actions) to minimize impacts on natural resources (3) Invasive, Nonnative Species. The Reserve's management plan encourages minimizing the impact and presence of invasive, nonnative plants, including monitoring and removing nonnative plants; preventing new introductions by working with public utilities, local governmental agencies, and recreationists that use the Reserve; and restoring disturbed and degraded areas with native species. (4) Fire. The CDFW management plan for the Reserve calls for coordination among the Santa Barbara County Fire Department, enforcement agencies, local governmental agencies, and adjacent small and large landowners to ensure that fire risk is reduced, that new development projects adjacent to the Reserve are reviewed by CDFW staff and address fuel reduction needs and requirements, and that appropriate and efficient post-fire remediation takes place, where needed. Reducing the risk of fire would limit the potential for wildfire to occur within Vandenberg monkeyflower habitat, and thus reduce the impact of fire suppression activities and the impact of invasive, nonnative plants invading the habitat post-fire. No controlled burns within Vandenberg monkeyflower habitat have occurred to date. (5) Recreation. CDFW developed a trails plan that shows existing trails within the Reserve as well as proposed new trail construction; seasonal trail closures or restrictions may occur to protect sensitive resources such as wildlife breeding locations or rare plant assemblages that vary from year to year (Gevirtz et al. 2007, p. 70). This system of trails would reduce the risk of authorized recreational uses directly impacting suitable Vandenberg monkeyflower habitat. The management plan calls for maintaining public access to the Reserve through pedestrian hiking trails by providing a network of trails, including loop trails, linking interesting areas while protecting resources, and preventing unauthorized uses (Gevirtz et al. 2007, p. 231).

- La Purisima Mission State Historic Park: A general management plan for La Purisima Mission SHP was completed in 1991, and an ecosystem characterization of La Purisima Mission SHP was completed in 2005. Directives specific to La Purisima Mission SHP that concern the habitat where Vandenberg monkeyflower occurs include preserving Burton Mesa chaparral, protecting and managing rare and endangered plants in perpetuity, controlling nonnative plants that have become established, and developing a prescribed-burn plan. Conservation measures are proposed in the general management plan, as outlined below, with implementation contingent upon available funding and staffing. (a) Development. There are multiple existing structures within the park, and any new structures must provide for visitors' needs without competing for attention with historical buildings or the natural setting. All new development must be sensitive to that purpose of providing appropriate visitor facilities without detracting from the historical and natural setting of La Purisima Mission. Burton Mesa chaparral habitat areas are designated as low-intensity use areas. Therefore, any new development is unlikely to impact Vandenberg monkeyflower or its habitat in the park. (b) Invasive, Nonnative Species. California State Parks' resource management programs try to remove or control invasive, nonnative species and reestablish indigenous native species. (c) Fire. In 2007, California State Parks initiated development of a wildfire management plan that would include management strategies to protect the existing infrastructure (buildings) and protect cultural resources and biological resources of the park (which would include Vandenberg monkeyflower habitat), as well as informing fire suppression agencies of the areas with high-value resources and the limits of fire suppression activities in those areas. No prescribed burns currently occur within the park. (d) Recreation. Consideration will be given to designating trails for specific types of uses and constructing new trail segments to avoid conflicts (California State Parks 1991, p. 65). The trail system requires continual brush and erosion control, in which California State Parks often relies on numerous volunteers such as scouts and environmental groups to assist the park each year in various projects, from litter pickup to trail construction. A designated trail system would reduce the risk of authorized recreational uses directly impacting Vandenberg monkeyflower habitat. However, the best available information indicates that recreational activities are currently having minimal to no effect on Vandenberg monkeyflower habitat at La Purisima Mission SHP
- 1. Manage habitat that supports the species to reduce or eliminate threats, including but not limited to seeding for augmentation; supplemental irrigation and shading for temperature reduction to offset future climate change effects; invasive weed removal and abatement; mechanical disturbance; vegetation thinning and removal to open canopy and maintain desired cover; and import, transfer, and redistribution of sand. (Priority 1) (USFWS,

2024)

- 2. Develop and implement a standardized annual monitoring protocol to identify population trajectories and environmental conditions that might be adversely affecting the species. (Priority 1) (USFWS, 2024)
- 3. Secure currently unprotected habitat where the species occurs or could occur from future destruction and development. (Priority 2) (USFWS, 2024)
- 4. Encourage partners to incorporate conservation measures for the species and its habitat into their projects and into all local and regional, strategic planning documents and programs. (Priority 3) (USFWS, 2024)
- 5. Collect seed from all three populations and deposit accessions into permanent conservation seed banks. (Priority 2) (USFWS, 2024)
- 6. Conduct experimental research projects, including those that examine the roles of biotic and abiotic environmental effects, natural soil seed banks, disturbance regimes, invasive weed management techniques, herbivory and seed predation, genetics, effects of fire and controlled burns, and the species' pollination system. (Priority 2) (USFWS, 2024)

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# SPECIES ACCOUNT: *Dodecahema leptoceras* (Slender-horned spineflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 9/28/1987; Pacific Southwest Region (R8) (USFWS, 2015)

**Physical Description**

An annual plant that has a distinctive basal rosette of leaves ranging from 3 to 8 centimeters (cm) (1.2 to 3.1 inch (in)) in diameter. The leaves frequently become reddish at maturity. The flower stalks are branched and erect 3 to 10 cm (1.2 to 4 in) tall . Flowers are arranged in clusters along the flower stalks and each cluster is surrounded by an involucre (a ring of modified leaves beneath a flower cluster). Characteristic of this species, each of the 6 involucre segments has an awn at its base as well as at its apex. This feature distinguished this genus from the closely related genera Chorizanthe and Centrostegia (Reveal and Hardham 1989, p. 86). The flowers are white to pink, 1.2 to 2 millimeters (mm) (0.5 to 0.8 in) long, each producing a single achene (a dry single-seeded fruit), 1.7 to 2 mm (0.06 to 0.08 in) long (USFWS, 2010).

**Taxonomy**

In the buckwheat family (Polygonaceae). At the time of listing, the species was classified as Centrostegia leptoceras A. Gray. A reassessment of the distinct morphology of the involucre and relationships to other closely related taxa resulted in a taxonomic revision. The current recognized name for slender horned spineflower is Dodecahema leptoceras (A. Gray) Reveal and Hardham (Reveal and Hardham 1989, p. 85) (USFWS, 2010).

**Historical Range**

See current range/distribution.

**Current Range**

Southwestern California, in the foothills of the San Gabriel Mountains in Los Angeles County, the San Bernardino Mountains in San Bernardino County, and the San Jacinto Mountains in western Riverside County (USFWS, 2010).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

<u>Adult:</u> The level of gene similarity (or homozygosity) detected in this species indicates that Dodecahema leptoceras has a mixed mating system (e.g., seed is produced both through pollination between flowers on a single plant and between flowers on different plants), but the latter condition, outcrossing, is more prevalent. The level of gene similarity (or homozygosity) detected in this species indicates that Dodecahema leptoceras has a mixed mating system (e.g., seed is produced both through pollination between flowers on a single plant and between

flowers on different plants), but the latter condition, outcrossing, is more prevalent (USFWS, 2010).

**Habitat Type**

Adult: Terrestrial (USFWS, 2010)

**Habitat Vegetation or Surface Water Classification**

Adult: Alluvial scrub on sandy and gravelly soils in sandy wash systems (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevation range of 656 to 2,296 feet (USFWS, 2010)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2010)

**Habitat Narrative**

Adult: Species habitat is alluvial scrub on sandy and gravelly soils in sandy wash systems, at elevations ranging from 656 to 2,296 feet, in areas where intermittent, scouring flood events occur (USFWS, 2010). Soils are riverbed alluvium high in silt and low in organic matter (NatureServe, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal may be by small animals or sheet flows during heavy rains (USFWS, 2010).

***Population Information and Trends***

**Population Trends:**

Decline of 70-90% (NatureServe, 2015)

**Species Trends:**

Decline of >50% (NatureServe, 2015)

**Number of Populations:**

15 occurrences are extant, 13 are presumed extant, 7 are possibly extirpated, and 9 are extirpated (USFWS, 2022)

**Population Size:**

2500 - 10,000 individuals (NatureServe, 2015)

**Population Narrative:**

The alluvial terrace habitat where this species lives has been severely altered, degraded and destroyed over the past 100 years. The long-term trend is a decline of 70-90%; the short-tern trend is a decline of >50%. Thousands of individuals at the San Jacinto River and Temescal Canyon sites. A total of 35 occurrences are known, however, only 19 are non-historic. While several populations are known to be extirpated or historic, between 1/3-2/3 of the story of loss and decline is known. In other words, it is suspected that more decline is occurring than researchers know about (NatureServe, 2015).. Of the 11 spineflower occurrences in Los Angeles County, 1 is extant, 2 are presumed extant, 3 are possibly extirpated, and 5 are extirpated. of the 17 spineflower occurrences in Riverside County, 8 are extant, 7 are presumed extant, 1 is possibly extirpated, and 1 is extirpated. of the 16 spineflower occurrences in San Bernardino County, 6 are extant, 4 are presumed extant, 3 are possibly extirpated, and 3 are extirpated (Table 2). Two occurrences are new since 2010 (USFWS, 2022). We reviewed data from the CNDDB, CCH2, Habitat Conservation Plans, project-related surveys, and the Forest Service to update spineflower occurrence numbers and status. Our 2010 5-year review identified 36 occurrences of spineflower. Twenty were presumed extant, 3 were possibly extirpated, and 13 were extirpated (Table 1). This 2022 review of new information finds that there are 44 occurrences of spineflower. Eight occurrences that were not considered in the 2010 5-year review have been either (1) discovered since 2010, or (2) were known to others but not included in our last review. Across the range of spineflower in Los Angeles, Riverside, and San Bernardino counties, 15 occurrences are extant, 13 are presumed extant, 7 are possibly extirpated, and 9 are extirpated (Table 1). Since 2010, conservation land acquisition has occurred at or adjacent to three occurrences of spineflower. The spineflower is also a covered species under the draft Upper SAR HCP and the 2020 Wash Plan, which will implement measures to help conserve and manage for the species (USFWS, 2022).

### *Threats and Stressors*

**Stressor:** Habitat destruction or modification (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The current threats to habitat are urban and agricultural development, mining, altered hydrology, off-highway vehicle activity, trash dumping, fire, invasive nonnative plants, and other habitat degrading activities (USFWS, 2010).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Endangered Species Act is the primary Federal law that has provided protection for this species since its listing as endangered in 1987 (USFWS 1987, pp. 36265-36270). Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act (USFWS, 2010).

**Stressor:** Climate change (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change refers to a shift in the mean or variability in measures of climate (e.g., precipitation or temperature) that persists for an extended period of time, typically a decade or more, due to natural variability, human activity, or both (IPCC 2013, p. 1450). In our 2010 5- year review, we considered climate change a threat to spineflower (Service 2010, pp. 24–25). Since 2010, scientists have used downscaled climate models to project changes in temperature and

precipitation in California under a range of future climate scenarios (Kalansky et al. 2018, entire; Pierce et al. 2018, entire). Temperature has increased throughout Southern California over the past century, and warming is expected to continue (Table 3) (Hall et al. 2018, pp. 10–11). Wet and dry precipitation extremes are projected to increase in the future, although models project small mean changes compared to historical precipitation variability (Hall et al. 2018, p. 13). Models also project increases in the frequency of atmospheric-river storms, which deliver intense precipitation and can cause severe flooding (Dettinger 2011, p. 519). However, droughts are also projected to become more frequent and intense and will be exacerbated by higher temperatures (USFWS, 2022).

**Stressor:** Dumping and trash (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In our 2010 5-year review for spineflower, we identified trash dumping as a threat at three spineflower occurrences but noted that the incidence of trash dumping could be higher than reported (Service 2010, p. 16) (USFWS, 2022).

**Stressor:** Rangewide altered hydrology (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Rangewide altered hydrology and other ongoing threats are still present at spineflower occurrences. Thirty-six percent of occurrences (16 of 44) are extirpated or possibly extirpated due to development and altered hydrology, and 30 percent of occurrences (15 of 44) have not been observed for over 10 years (i.e., are presumed extant) (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
Not available.

Recovery Priority Number: 7C

**Delisting Criteria:**
Not available.

**Recovery Actions:**

- There is no final approved recovery plan for this species (USFWS, 2010).
- Monitor known and historical occurrences as well as suitable habitat to determine presence and condition of Dodecahema leptoceras.
- Identify opportunities to work with private landowners to encourage conservation actions for Dodecahema leptoceras on sites that are not conserved. This could be done through the Partners for Fish and Wildlife Program as well other cooperative programs.
- Determine by experimental means and field studies the extent to which the presence of invasive nonnative plants impacts growth and persistence of Dodecahema leptoceras.
- Identify pollen and seed (fruit) vectors and their habitat requirements. Incorporate these requirements into habitat management considerations for Dodecahema leptoceras.

- Identify the structure and dynamics of the seed bank of Dodecahema leptoceras

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS To recover slender-horned spineflower, we need to conserve additional spineflower habitat and enhance or restore degraded habitat. To accomplish these actions, we also need additional monitoring, surveys, and site assessment across the species' range. We recommend that the following actions be completed over the next 5 years to enhance habitat and manage threats to slender-horned spineflower. We recognize that conservation of this species will require cooperation and coordination with partners. 1. Monitor known and historical occurrences to determine presence and condition of spineflower. Evaluate threats and develop site-specific recommendations to prioritize management actions. 2. Model suitable habitat across the range of spineflower and prioritize areas for further survey. Work with interested landowners to survey suitable habitat where spineflower has not been detected. 3. Collect spineflower seed from occurrences outside the Wash Plan area and conserve seed in an off-site conservation seed bank. 4. Enhance spineflower habitat using the site-specific recommendations developed under action 1. 5. At spineflower occurrences that are not conserved, identify opportunities to work with landowners to acquire lands or encourage conservation actions for spineflower. 6. Over the next 10 years, identify adaptive management and monitoring approaches from the Spineflower Working Group that could be applied range-wide, especially in regard to invasive species management and hydrological conditions (USFWS, 2022).

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# SPECIES ACCOUNT: *Dudleya abramsii ssp. parva* (Conejo dudleya)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 2/28/1997; Pacific Southwest Region (R8)

**Physical Description**

A succulent dicot, rosette-forming perennial herb with vernal leaves (summer deciduous), an inflorescence stem 5 to 18 centimeters long, and pale yellow-green flowers that often exhibit flecks of red on the keel. The roots are constricted at irregular intervals . (USWS, 2015)

**Taxonomy**

In the stonecrop family (Crassulaceae). Dudleya parva was recognized as a distinct species by Munz and Keck in 1959 and 1968, Nakai in 1983, and Moran in 1980 (McCabe in litt. 2008a). In 1991, Bartel published a revision treating D. parva as a subspecies of D. abramsii (Bartel 1991) based on similarities between the flowers of D. abramsii and D. parva noted by Reid Moran (1948). However, D. parva and D. abramsii have differing micromorphological leaf surface characters, caudex diameters, and wound responses that appear to clearly separate the two (McCabe in litt. 2008a). The name of this species has been returned to Dudleya parva (from Dudleya abramsii ssp. parva) as of November 2006. (USFWS, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Known locations are in a narrow band of recorded occurrences along a 10-mile stretch of land from the western portion of the Simi Hills, through Mountclef Ridge, to the Conejo Grade in Ventura County, California (USFWS, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: Unknown; up to 24 years in cultivation (USFWS, 2015)

**Breeding Season**

Adult: Blooms in late spring (May-June) (USFWS, 2015)

**Key Resources Needed for Breeding**

Adult: Bees and flies for pollination (USFWS, 2015)

**Reproduction Narrative**

Adult: Blooms in late spring (May - June), and is pollinated by bees and flies. D. parva tends to exhibit a higher degree of auto-fertility and is prone to pollinator unreliability, short and unpredictable reproductive seasons, small population size, and high population turnover. D. parva will hybridize with some of the other Dudleya species (e.g., D. pulverulenta), which is typical of the Dudleya genus. Seeds sprout in the winter when there is ample precipitation and continue to grow throughout the rainy season. The plants may spread slowly underground by roots or stems, and any stem within 2 to 3 cm (0.8 to 1.2 in) of a centrally established individual may be a clone of that individual (USFWS, 2015).

**Habitat Type**

Adult: Terrestrial (USFWS, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Scattered rock outcrops in grassland and cactus dominated coastal sage scrub habitat (USFWS, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevations ranging from 60 to 450 meters (USFWS, 2015)

**Environmental Specificity**

Adult: Very narrow (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: On a broad scale, suitable habitat for Dudleya parva is comprised of coastal sage scrub and valley and foothill grassland with clay or volcanic soils, at elevations ranging from 60 to 450 meters (180 to 1350 ft), and on slopes ranging from 0 to 90 degrees, but most commonly on north-facing slopes of approximately 10 degrees. This species is highly localized in its distribution, occurring exclusively in thin-soiled substrate over rocky outcrops derived from the Miocene Conejo volcanics (USFWS, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal information is not available (inferred from USFWS, 2015).

***Population Information and Trends***

**Population Trends:**

Stable (inferred from USFWS, 2015)

**Species Trends:**

Stable (inferred from USFWS, 2015)

**Number of Populations:**

14 (USFWS, 2015)

**Population Size:**

~150,000 individuals (USFWS, 2015)

**Population Narrative:**

The population boundaries and numbers for Dudleya parva exhibit some annual fluctuations; however, the species has generally remained in the same suitable habitat areas noted at the time of listing in 1997. Since the time of listing, the number of documented individuals within the noted occurrences of the species has increased in some cases, while decreasing somewhat in others; however, the information gathered from the more recent population surveys seems to show that overall the species has remained at relatively constant levels since the time of listing. While many of the sites occur on private lands and could not be adequately surveyed, the numbers of plants that were seen on public lands have substantially increased in a few areas. Observed increases from different population surveys does not represent an actual increase in the number of plants, but rather is likely a result of the more thorough surveys (USFWS, 2015).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat encroachment from new or existing development, fire suppression activities, human recreational activities (such as hiking, rock climbing, biking, and horseback riding) continue to be a threat (USFWS, 2015).

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Due to the accessibility of some of the habitat sites to the public and the appeal of Dudleya species to horticulturalists, collection still constitutes a threat to the species. However, due to the vernal nature of this species (leaves wither and fall off in the summer), it may be slightly less attractive to collectors than non-vernal species (USFWS, 2015).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Endangered Species Act is the primary Federal law that has provided some level of protection for Dudleya parva since its listing as threatened in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act (USFWS, 2015).

**Stressor:** Other natural or manmade factors affecting its continued existence (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The low numbers of individuals and limited range of Dudleya parva make it particularly vulnerable to extinction from random human-caused or natural events. Dudleya

parva is potentially threatened by: (1) pre-fire fuel-reduction activities, such as removal of native vegetation and disturbance of soils that can reduce habitat quality; (2) the wildfire itself, in which the intense heat can kill or set back the growth of individuals; and (3) fire suppression activities, including the disturbance of native vegetation and soils during the grubbing of fire lines and the dropping of fire retardants, the latter of which increases soil nitrogen and stimulates the growth of non-native grasses that could compete with D. parva (USFWS, 2015).

**Stressor:** Climate change effects (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 2009 5-year review (Service 2009 p.14) introduced climate change as a threat to Dudleya abramsii ssp. parva. Threats resulting from climate change may be complex, and include physical stress, death by erosion, increased competition, and increased likelihood of fire. Expected climate change for the Los Angeles area predicts rising annual and extreme high temperatures (Hall et al. pp. 10-11) and more episodic rainfall with more extreme floods and drier droughts (Hall et al. pp. 11-14, 18). Changes in climate could threaten Dudleya abramsii ssp. parva in several ways. First, although the species is dormant in the dry part of the year, more intensely dry summers with long-term drought could kill plants (Burgess (in litt. 2022). Second, more intense precipitation and erosion could cause slope slippage, destroying plants. Third, with changing climate, non-native annual grasses are expected to increase in dominance both as a result of increased fire frequency (Hall et al. 2018 p. 53) and with increasing annual temperatures (Sandel and Dangremond 2012 entire). The increased annual grass dominance can both promote more fire and may have negative competitive effects on Dudleya abramsii ssp. parva. Because it characteristically occurs in rocky areas with sparse vegetation that does not carry fire well, this may not negatively affect the species. However, if non-native annual grass cover does increase and fires do increase in frequency or intensity at Dudleya abramsii ssp. parva occurrences, the species could be negatively impacted. The threat of climate change on Dudleya abramsii ssp. parva remains (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Not applicable.

**Delisting Criteria:**
1. All current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity (USFWS, 1999).

2. All current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years (USFWS, 1999).

**Recovery Actions:**
- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).

- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)
- Recommendation for Future Action from 2015 5-Year Review: Conduct new, up-to-date, extensive population surveys of known occurrences and areas of suitable habitat. - Develop and implement monitoring and adaptive management plans for known existing occurrences. Monitoring should occur at intervals of 3 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. - Update and expand knowledge of the species’ life history and specific habitat requirements (USFWS, 2015).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The recommendations for future actions largely mirror those of the 2015 5-year review (Service pp.22-23): 1. Conduct thorough population surveys of known occurrences and areas of suitable habitat. 2. Develop and implement a monitoring plan for known existing occurrences. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 3. Work with public and private landowners to raise public awareness of the species to support appropriate conservation measures. 4. Update and expand knowledge of the species’ life history and specific habitat requirements. 5. Improve the completeness of coverage of Dudleya abramsii ssp. parva in conservation seed banks, with more occurrences over more years (USFWS, 2023).

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# SPECIES ACCOUNT: *Dudleya cymosa ssp. marcescens* (Marcescent dudleya)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

A perennial herb that forms a rosette of succulent leaves in the spring, withering in summer. The rosette leaves are 1.5 to 4 centimeters (0.6to 1.6 inches) long, 5 to 12 millimeters (2.0 to 4.7 inches) wide; the caudex (stem) is 2 to 7 centimeters (0.8to 2.8 inches) thick, flowering stems are 4 to 10 centimeters (1.6 to 4 inches) tall and the corolla is bright yellow, to yellow with red markings, to bright red (Munz 1974; Hickman 1993). (USFWS, 1999)

**Taxonomy**

Dudleya cymosa was described by Charles Antoine Lemaire in 1858 as Echeveria cymosa based on a collection sent to him by horticulturist Louis de Smet of Ledeburg, Belgium; unfortunately, the type locality is unknown and the type specimen has been lost (Moran 1951). Britton and Rose (1903) included this species in their newly described genus Dudleya, as D. cymosa (Moran 1951). Other subspecies of D. cymosa range throughout the Sierra Nevada, the coast ranges, the transverse ranges, and the northern portion ofthe peninsular ranges. Dudleya cymosa ssp. marcescens differs from other subspecies of D. cymosa in that its rosette leaves wither in the summer, but do not fall off (i.e., they are marcescent). (USFWS, 1999)

**Historical Range**

See current range/distribution.

**Current Range**

Dudleya cymosa ssp. marcescens is endemic to the Santa Monica Mountains in California and is known from a 24-km (15-mi) stretch between Hidden Valley and Malibu Creek State Park (Raven et al. 1986). The total area that encompasses all of the known D. cymosa ssp. marcescens occurrences is approximately 230 square km (88 square mi) (USFWS, 2009).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: Dudleya cymosa ssp. marcescens is pollinated by hummingbirds and bees, and produces an abundant amount of small seed. (USFWS, 2009)

**Breeding Season**

Adult: May to June (USFWS, 2009)

**Reproduction Narrative**

Adult: Flowering generally occurs between May and June and produces fruits with five follicles that split open to release abundant small seeds in late summer or early fall (Skinner and Pavlik 1994, Dorsey 2007). Dudleya cymosa ssp. marcescens is pollinated by hummingbirds and bees, and produces an abundant amount of small seed. Pollination services to D. cymosa ssp. marcescens may be less than for other Dudleya taxa because they grow on rock faces with no other flowering plants to attract pollinators. The seeds of D. cymosa ssp. marcescens range from 0.2 to 1.2 millimeters (0.008 to 0.047 inch) in diameter (Wall 2008). Compared with other rare Dudleya taxa found in the Santa Monica Mountains, D. cymosa ssp. marcescens had a relatively low reproductive output and low seed germination that may put it in greater danger of extinction than other rare Dudleya taxa (Dorsey 2007). (USFWS, 2009)

**Habitat Type**

Adult: Terrestrial (USFWS, 2009)

**Habitat Vegetation or Surface Water Classification**

Adult: Sheer volcanic cliffs and canyon walls in canyons with perennial streams (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Grows with mosses and lichens in places too step for soil to form (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (USFWS, 2009)

**Dependency on Other Individuals or Species for Habitat**

Adult: Riefner and Bowler (1995) hypothesize that the fog-capturing lichen found in the coastal bluffs and cliffs of California may trap Dudleya seeds, provide nutrients and water, and may protect young plants from snail and slug herbivory. (USFWS, 2009)

**Habitat Narrative**

Adult: suitable habitat for Dudleya cymosa ssp. marcescens is generally located on the lower reaches of volcanic rock outcrops adjacent to streams, chaparral, and coast live oak (Quercus agrifolia) woodland (CNDDB 2008, NPS 2003). In most locations, the topographic relief has prevented deep soil formation; therefore, this species may be the only flowering plant occurring in a microhabitat that is otherwise dominated by mosses, lichens, and ferns (CNDDB 2008). The mosses and lichens may play a crucial role in trapping D. cymosa ssp. marcescens seeds and allowing them to germinate and establish on the volcanic outcrops (Riefner and Bowler 1995, Riefner and Wishner 2000). (USFWS, 2009)

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Animals (USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: The grouping of the plants along the watershed corridor may indicate a dispersal mechanism that is driven by water or short-distance wind dispersal. The seeds of D. cymosa ssp.

marcescens are very small in size and may be easily transported by water, wind, or animals within and outside of the watershed (Wall 2008). (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

14 (USFWS, 2023)

**Population Size:**

>6,000 total (USFWS, 2023)

**Population Narrative:**

According to EO records available through the CNDDB, field surveys from the National Park Service (NPS), and seed collection studies, 13 sites currently or historically supported Dudleya cymosa ssp. marcescens. The most recent surveys, completed in 2003 by NPS and in 2005 by Dorsey, indicate that the total number of individuals of D. cymosa ssp. marcescens throughout its range is approximately 12,000. (USFWS, 2009). At the time of listing in 1997 (Service 1997), there were 7 known occurrences of Dudleya cymosa ssp. marcescens. The number of known occurrences has gradually increased to 14 (Table 1, Service 1999 p. 27, Service 2009 p. 6, Dorsey et al. 2013 pp. 29-41; CNDDB 2023 (last updated 2015), Guilliams and Hasenstab-Lehman 2021 pp. 35-37). Most of these occurrences have been recently confirmed as extant (Guilliams and Hasenstab-Lehman 2021 pp. 35-37). Nine of the occurrences are at least partially on public land, and thirteen of the fourteen occurrences are in the fire footprint of the 2018 Woolsey Fire (Guilliams and Hasenstab-Lehman 2021 p. 27). Unpublished data suggest that several known occurrences of Dudleya cymosa ssp. marcescens are more extensive than currently documented and that there may be several undocumented occurrences (Devlin Gandy pers. comm. 2023). If the undocumented occurrences are verified, the range of the species would extend by 1.5 km (1 mi) to the west and 4.5 km (3 mi) to the east (USFWS, 2023). Twelve of the 14 known occurrences were surveyed in 2020 and a total of 6,148 individuals were found (Table 2, Guilliams and Hasenstab-Lehman 2021 pp. 35-37, 42-43). Two of the occurrences were not surveyed because they could not be located. The study also assessed trends in abundance and concluded that two thirds of the surveyed occurrences were stable and one third were declining over time. No occurrences were considered to be increasing. Some of the occurrences were scored as “stable” despite having fewer individuals over time (EO 7, EO 13), because it was felt they were in the process of recovering from moderate effects of the 2018 Woolsey Fire. In general, declines can be attributed to the effects of the Woolsey Fire, which burned 11 of the 12 occurrences observed during the 2020 surveys (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Recreation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Dudleya cymosa ssp. marcescens habitat is often used for rock climbing and rappelling (Service 1997). These activities have the potential to destroy the moss substrate that the species depends on and can tear out individual plants. Rock climbing and rappelling may occur on both public and private land where D. cymosa ssp. marcescens occurs. Popular rock climbing areas located in the vicinity of known D. cymosa ssp. marcescens occurrences include Planet of the Apes Wall, Ghetto Wall, Echo Cliffs, and Century Lake Canyon (The Mountain Project 2008, Rockclimbing.com 2008).

**Stressor:** Vandalism (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** On April 27, 2009 the Service was notified by NPS staff that large swaths of moss that support Dudleya cymosa ssp. marcescens had been damaged at the Seminole Hot Springs occurrence (Sagar 2009). The moss appeared to be scraped away from the rock face to form pictures and initials (Figure 3). An unknown number of individual plants have been damaged or destroyed by the disturbance (Figure 4). The site appears to be used as a local social gathering place, and will likely suffer recurring damage if some type of protective action is not taken (e.g. closing the site to public access, posting signage, etc.).

**Stressor:** Development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the rule listing the species, we also discussed that occurrences are located on both public and private lands, and that individuals of Dudleya cymosa ssp. marcescens on private lands may be threatened by development. One occurrence on private land, Seminole Hot Springs, is owned by the Mountains Restoration Trust, a non-profit land trust dedicated to preserving natural land in the Santa Monica Mountains. This site is protected from development, but is threatened by recreational activities as demonstrated by the damage to the moss substrate observed in 2009. For the other six occurrences on private lands, local zoning designations can provide some information about the potential for development at each site. Private lands that support D. cymosa ssp. marcescens individuals are primarily zoned for open space or agriculture, with certain parcels in Ventura County falling under the Santa Monica Mountains Overlay Zone, which provides protections for sensitive species including D. cymosa ssp. marcescens. (USFWS, 2009)

**Stressor:** Overutilization (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing in 1997, we discussed that species of Dudleya are collected by professional horticulturalists as well as amateur collectors and gardeners (Service 1997). We believe that collection still may constitute a threat to the species. Although we do not have specific reports of vandalism for D. cymosa ssp. marcescens, we believe that, due to the accessibility of certain populations to the public, collection still constitutes a threat to the species. (USFWS, 2009)

**Stressor:** Fire (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing Dudleya cymosa ssp. marcescens in 1997, we discussed that fire can be a natural or human caused factor affecting D. cymosa ssp. marcescens (Service 1997). The ecosystems of the Santa Monica Mountains have evolved with periodic lightning-caused fires that were generally small in size and intensity, but occurred at frequent intervals (NPS 2007b). With the expansion of human settlement, it has been suggested that large fires are the result of effective suppression of small fires (NPS 2007b). Fire has been observed to reduce moss substrate that D. cymosa ssp. marcescens requires (Dedero 1992). Furthermore, it may be assumed that large fires pose a greater threat to D. cymosa ssp. marcescens because large fires may have a greater flame height and burn temperature that may impact the rocky outcrops that might otherwise be unaffected by small fires with lower flame heights and burn temperatures. Large fires may also burn through the entire range of the species whereas small fires would cover less area. (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, IPCC 2007). Based on modeling, they predicted that species' distributions will shift in response to climate change, and that species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Dudleya cymosa ssp. marcescens, small-ranged species, such as D. cymosa ssp. marcescens, are generally more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008). Some Dudleya taxa have evolved characteristics such as facultative leaf withering (McCabe et al. in prep. 2008) and switching between CAM and C3 photosynthesis pathways (Thorghton et al. 1977), which allow them to live in water-limited environments and adapt to climate fluctuations. These characteristics may benefit the species in the face of a changing climate. (USFWS, 2009)

**Stressor:** Climate change effects (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 2009 5-year review introduced climate change as a threat to Dudleya cymosa ssp. marcescens (Service 2009 p. 13). Effects of climate change for the Los Angeles area include predicted rising annual and extreme high temperatures (Hall et al. pp. 10-11) and increased episodic rainfall with more extreme floods and drier droughts (Hall et al. pp. 11-14, 18). Changes in climate could threaten Dudleya cymosa ssp. marcescens through habitat degradation or migration, mortality through drought or erosion, and increased non-native annual grasses leading to greater competition or fire susceptibility (Service 2009 p. 13). Recently, the current effects of non-natives and erosion were assessed to be low for the taxon (Guilliams and

Hasenstab-Lehman 2021 pp. 42-43). As climate changes and vegetation shifts, optimal habitat for Dudleya cymosa ssp. marcescens may also shift, and the taxon may not be able to disperse far and fast enough to match the vegetation shift. Although the taxon is dormant in the dry part of the year, more intensively dry summers with long-term drought could kill plants. Conversely, more intense precipitation could cause increased erosion on the steep cliff habitat of Dudleya cymosa ssp. marcescens, destroying plants. Non-native annual grasses are expected to increase in dominance because of increased fire frequency (Hall et al. 2018 p. 53) and with increasing annual temperatures (Sandel and Dangremond 2012 entire). The increased annual grass dominance can in turn both promote more fire and may have more negative competitive effects on Dudleya cymosa ssp. marcescens. Because the taxon characteristically occurs on steep cliffs with sparse vegetation that does not carry fire well, this may not negatively affect the taxon. However, if non-native annual grass cover does increase and fires do increase in frequency or intensity at Dudleya cymosa ssp. marcescens occurrences, the taxon could be negatively impacted. The threat of climate change on Dudleya cymosa ssp. marcescens remains (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 6

**Delisting Criteria:**
1. All the current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)

2. All the current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

**Recovery Actions:**
- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public’s understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)
- Establish a monitoring strategy to understand the population and demographic dynamics of Dudleya cymosa ssp. marcescens. The minimal survey data that is available indicates that many of the populations may be stable or increasing. However, without population data at all sites, abundance trends cannot be determined; without demographic data, population stability cannot be presumed. At a minimum, all known occurrences should be surveyed for abundance and demographics. If survey results indicate that populations are stable or increasing, and all occurrences have multiple age classes, indicating regular recruitment, the species may be considered to be self-sustaining. If survey results indicate that populations

are declining or demographics show a single age class, further monitoring will be required to determine population trends. (USFWS, 2009)

- Work with the National Park Service and California Department of Parks and Recreation to identify Dudleya cymosa ssp. marcescens occurrences on public lands that may be degraded by recreational activities such as climbing, and conduct a study to clearly identify impacts to the species caused by recreational activities. If impacts are identified, install fencing, signage, or other mechanisms to eliminate threats to the plants and their habitat. (USFWS, 2009)
- Work with rock climbing leaders, organizations, and websites to make them aware of the sensitive species that may occur in the vicinity of their climbing areas. Explore the possibility of establishing “best climbing practices,” such as avoiding vegetation on rock faces, and not establishing new climbing sites on rock faces that are vegetated. (USFWS, 2009)
- Work with the Mountains Restoration Trust and other partners to reduce impacts to the individuals and habitat at Seminole Hot Springs by installing signage, installing fencing, closing the area to visitors, or using other means to eliminate recreational threats. (USFWS, 2009)
- Work with private landowners at locations where zoning may permit development to raise awareness of the species. Cooperation with landowners is crucial to monitoring and protecting Dudleya cymosa ssp. marcescens occurrences on private lands. (USFWS, 2009)
- Work with Ventura County and Los Angeles County to educate them about Dudleya cymosa ssp. marcescens, so that when issuing development permits the counties are able to identify developments that may impact the species and encourage measures that would protect the species. (USFWS, 2009)
- Survey previously uninvestigated areas with potentially suitable habitat within and adjacent to the known range of Dudleya cymosa ssp. marcescens to determine if habitat and individuals are present. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue genetic, common garden, and other analyses to determine if Dudleya cymosa ssp. marcescens is a valid narrow taxon, or part of the range of variation of a more widespread and abundant taxon. 2. Conduct thorough surveys of known occurrences, adjacent areas, and other areas of suitable habitat to potentially increase the extent of known occurrences and document new occurrences. Develop and implement a monitoring plan. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 3. Work with public and private entities to prevent damage to plants and to raise public awareness to support appropriate conservation measures. 4. Update and expand knowledge of the taxon’s life history and specific habitat requirements, especially regarding fire. 5. Improve the completeness of coverage of Dudleya cymosa ssp. marcescens in conservation seed banks, with more occurrences over more years (USFWS, 2023).

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# SPECIES ACCOUNT: *Dudleya cymosa ssp. ovatifolia* (Santa Monica Mountains dudleyea)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

A perennial herb that forms a rosettes of evergreen, succulent leaves. Leaves are 2 to 5 cm (0.8 to 2.0 in long, 1.5 to 2.5 cm (0.6 to 1.0 in wide; floral stems are 4 to 15 cm (1.6 to 6.0 in tall; corollas are pale yellow (Munz 1974). The ovateleaves have a maroon underside. (USFWS, 1999; NatureServe, 2015)

**Taxonomy**

Dudleya cymosassp. ovatifolja was originally described as Dudleya ovatifolia by Britton (1903) based on a collection made by H.M. Hall in 1902. The type locality is listed as “Sierra Santa Monica,” thought to be Topanga Canyon, Los Angeles County (Moran 1951). The species was subsequently recognized as Cotyledon ovatifolia and Echeveria ovatifolia (Fedde 1904 and Berger 1930 respectively, cited in Moran 1951) when different generic concepts were used in the family Crassulaceae. Moran (1957) published the currently accepted combination of Dudleya cyrnosa ssp. ovatifolia. Nakai (1983) considered plants from near Agoura, Los Angeles County to be distinct from Dudleya cyrnosa ssp. ovatifolia. Subsequently, (Nakai 1987) published the new name D. cymosa ssp. agourensis. Nakai distinguished the new subspecies from the other on the basis of number and shape ofrosette leaves, pedicel length, and degree of spreading in petal apices. Nakai (1987) considered D. cymosa ssp. agourensis to differ from D. cymosa ssp. ovatfolia in having a simple- to several-branched caudex and glaucous elliptical basal leaves. Nakai (1987) noted that D. cyrnosa ssp. ovatifolia has an unbranched caudex and green, ovate basal leaves. Bartel (1993) apparently considered these differences consistent, and included D. cyrnosa ssp. agourensis in D. cymosa ssp. ovatifolia in his treatment of the genus Dudleya, for the Jepson Manual. (USFWS, 1999)

**Current Range**

Currently, there are four populations of what the Service considered to be Dudleya cymosa subsp. ovatifolia at the time of listing in Los Angeles and Orange Counties. This includes two in the Santa Monica Mountains, one in the Santa Ana Mountains, and one in Agoura Hills. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: The Dudleya species which have small yellow to orange flowers (including D. cymosa subsp. ovatifolia) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds. (USFWS, 2009)

**Breeding Season**

Adult: May to June (USFWS, 2009)

**Reproduction Narrative**

Adult: The flowering season is from May through June for D. cymosa subsp. agourensis and from March through May for D. cymosa subsp. ovatifolia (Dorsey 2007). The Dudleya species which have small yellow to orange flowers (including D. cymosa subsp. ovatifolia) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds. A study performed on Dudleya cymosa subsp. ovatifolia ex situ found that the average number of fruits produced per individual was 19 and the maximum number of seeds per fruit was 114. (USFWS, 2009)

**Habitat Type**

Adult: Terrestrial (USFWS, 2009)

**Habitat Vegetation or Surface Water Classification**

Adult: North-facing slopes and cliffs in chaparral communities and deep canyon bottoms (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Typically found on sedimentary conglomerate rock; persists in exposed dry habitat (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2009)

**Habitat Narrative**

Adult: On a broad scale, suitable habitat for Dudleya cymosa subsp. ovatifolia is generally located on sedimentary and conglomerate rock on canyon bottoms and shaded slopes in drainages along the south-facing slope of the Santa Monica Mountains (Dorsey 2007). In the Santa Ana Mountains, it occurs on shaded sandstone cliffs (Roberts 2008). Adjacent plant communities include coastal scrub and chaparral (CNDDB 2008b). In most locations, the topographic relief has prevented deep soil formation; therefore, this species may be the only flowering plant occurring in a microhabitat that otherwise supports mosses, lichens, and clubmoss (Selaginella spp.) (Dorsey 2007, CNDDB 2008b). (USFWS, 2009)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

4 (USFWS, 2009)

**Population Narrative:**

Currently, there are four populations of what the Service considers to be Dudleya cymosa subsp. Ovatifolia. (USFWS, 2009)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threat of habitat encroachment from new or existing development surrounding several of the known Dudleya cymosa subsp. ovatifolia (and D. cymosa subsp. agourensis) population sites continues to be a threat. Due to an increase in residential and commercial development in the surrounding and adjacent areas (City of Agoura Hills 2009), such fire suppression activities may be an increasing threat to both D. cymosa subsp. ovatifolia and D. cymosa subsp. agourensis (see Appendix 1 and 2) (Halsey 2006, Service 2007, Halsey in litt. 2008). However, because most occurrences are on rocky outcrops with little vegetative cover, we believe the threat is low at this time. (USFWS, 2009)

**Stressor:** Roadside scraping (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Roadside scraping for weed abatement has modified habitat for D. cymosa subsp. ovatifolia. Since most individuals occur on rocky substrates, the Service believe this threat would be confined to the margins of the populations that are along existing road edges. (USFWS, 2009)

**Stressor:** Recreation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recreational activities such as rock climbing and hiking were not discussed at the time of listing as a threat to the species. The Service considers this to be a new threat at certain locations. In Orange County, the Modjeska Peak occurrences (EOs #9 and 12) are located near a dirt road that is used by the public to access the peak, and Soza and Boyd (1999) noted the vulnerability of these occurrences and the presence of trash and footprints at EO #12; however, these occurrences are now thought to be a different Dudleya taxon (Roberts 2008). The Modjeska Canyon occurrence (EO #1) is inaccessible, and no visible signs of disturbance were seen in 1999 (Soza and Boyd 1999). Disturbance from recreational activities is also noted in CNDDB (2009) as a potential threat for the two populations in the Santa Monica Mountains, Los Angeles County. A site visit in 2009 confirmed that the Malibu Canyon population (EO #10) is being impacted by rock climbing activity (Marek in litt. 2009); the extent of recreational impacts on the Topanga Canyon population is unknown at this time. (USFWS, 2009)

**Stressor:** Collectors (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Dudleya species were included in the Smithsonian's list of Commercially Exploited Endangered and Threatened Species in the Continental United States, citing private collectors as a threat; although no specific reference to D. cymosa subsp. ovatifolia was made, D. cymosa subsp. marcescens was considered endangered by the authors and thus included (Ayensu and DeFillips 1978). Collection for horticultural purposes by professional horticulturists and amateur collectors and gardeners was identified as a threat to all of the Dudleya taxa including D. cymosa subsp. ovatifolia (inclusive of plants now identified as D. cymosa subsp. agourensis) in the 1997 final listing rule (Service 1997). (USFWS, 2009)

**Stressor:** Fire suppression and fuel modification (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Despite efforts to suppress fires in coastal southern California, the present fire frequency of every 15 years or less is substantially higher than it was historically, which, for coastal scrub, is thought to be every 50 to 100 years (Keeley 2006). Over a period of 60 years, most of the area in the Santa Monica Mountains has burned an average of three to five times, with an average interval of every 12.4 to 20.7 years (Radtke et al. 1982). An increase in fire frequency can result in type-conversion of chaparral and coastal sage scrub communities to annual invasive grasses which aggressively compete with native species for resources. However, because the specific sites where Dudleya cymosa subsp. ovatifolia grow are on rocky outcrops and would not support dense stands of chaparral or coastal sage scrub (Christy Brigham, Santa Monica Mountains National Recreation Area, pers. comm. 2009; CNDDB 2008a, b; Marek in litt. 2009), the Service believes that impacts from wildfires on the Dudleya taxa would likely be less severe than on the surrounding native plant communities. The practice of discing for fire prevention and suppression is unlikely to directly affect D. cymosa subsp. ovatifolia because it inhabits rocky outcrops. The spraying of fire retardant has been demonstrated to affect native species in grassland habitats outside California because they facilitate the growth of annual grasses (Larson and Newton 1996, Bell 2003). The impacts from their use on sites where D. cymosa subsp. ovatifolia occurs are unknown at this point in time. (USFWS, 2009)

**Stressor:** Competition with non-native species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In recent site visits, competition with non-native grasses has not been noted as a concern at any of the sites (Marek in litt. 2009, Roberts in litt. 2009, Soza and Boyd 1999). Jade plant (Crassula argentea), a non-native species from South Africa, was observed growing in Topanga Canyon within EO #2 by McCabe (Sagar in litt. 2008); its impacts on the Dudleya cymosa subsp. ovatifolia population are unknown. (USFWS, 2009)

**Stressor:** Stochastic extinction (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The Service now considers Dudleya cymosa ssp. ovatifolia to be threatened by stochastic events due to the small size and isolation of the populations. Conservation biology literature commonly notes the vulnerability of taxa known from small populations (Shaffer 1981, 1987; Meffe and Carroll 1997; Primack 1998). It is generally accepted that small populations have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Menges 1991, Ellstrand and Elam 1993, Shaffer 1981, 1987; Soulé 1987; Meffe and Carroll 1997; Primack 1998). Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (Wilcox and Murphy 1985, Meffe and Carroll 1997). Human development exacerbates the risk of stochastic extinction because it further isolates and fragments remaining populations as time goes on. (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, IPCC 2007). Due to the elevation and coastal location of the Santa Monica Mountains, this area is expected to become one of these potential future refugia and greatly increase in diversity (Loarie et al. 2008). We recognize that climate change is an important issue with potential effects to listed species and their habitats. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect small-ranged species that are restricted to soils of limited distribution, such as Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis, we acknowledge that they are more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 6

**Delisting Criteria:**
1. All current sites are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)

2. All current sites are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

**Recovery Actions:**
- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)

- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)
- Develop and implement monitoring and adaptive management plans for known existing occurrences of Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis populations. Monitoring should occur at intervals of 3 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. (USFWS, 2009)
- Work with private landowners and local agencies to protect and manage Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis on private property. If development is proposed or planned near D. cymosa subsp. ovatifolia and D. cymosa subsp. agourensis, recommend measures to protect the species such as creating large buffer zones between development and plants and invasive plant prevention and control. (USFWS, 2009)
- Work with local fire departments to: a) develop or modify fire management plans for when fires occur in or near the habitat of each species and b) prevent or limit discing of soil in fire management zones near Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis habitat to prevent the spread of invasive, nonnative plants. (USFWS, 2009)
- Once additional information concerning the status of populations and current threats is obtained, consider whether: a) a change in status for Dudleya cymosa subsp. ovatifolia may be warranted and, b) candidate status may be warranted for D. cymosa subsp. agourensis. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Regularly monitor Dudleya cymosa subsp. ovatifolia and Dudleya cymosa subsp. agourensis populations to evaluate population trends. 2. Improve the completeness of coverage of Dudleya cymosa subsp. ovatifolia, Dudleya cymosa subsp. agourensis, and undescribed taxa in conservation seed banks, with more occurrences over more years. 3. Confirm recent taxonomic changes, including the undescribed taxa in the Santa Ana Mountains, and recognize the segregation of the recognized undescribed taxa, Dudleya cymosa subsp. ovatifolia, and Dudleya cymosa subsp. agourensis. 4. Determine with more detail the distribution and status of all taxa in the Santa Ana Mountains that were considered part of Dudleya cymosa subsp. ovatifolia since listing. (USFWS, 2021)

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# SPECIES ACCOUNT: *Dudleya verityi* (Verity's dudleya)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

A perennial herb that forms a rosette of succulent leaves. Flowering stems are 5-15 cm tall, bearing lemon-yellow flowers. This plant forms colonies of up to 100 rosettes. (NatureServe, 2015)

**Taxonomy**

Dudleya verityi (Verity's dudleya) was described by Kei Nakai (1983) based on a collection he made in 1978 in Long Grade Canyon, Santa Monica Mountains, Ventura County. Raven and Thompson (1966) had assumed these plants to represent a southern extension of D. farinosa. During preparation ofthe 1977 revision ofthe flora, Dave Verity recognized these plants as representing a distinct species, and he subsequently encouraged Kei Nakai to review the taxonomy ofthe species. (USFWS, 1999)

**Historical Range**

See current range/distribution.

**Current Range**

All known occurrences are within eastern Ventura County, California, along north-facing volcanic rock outcrops on the lower slopes of the west end of the Santa Monica Mountains in coastal sage scrub. The entire distribution of the species is scattered over a 6.4-km (4-mi) stretch of land along the northern slope of Conejo Mountain and on north-facing volcanic outcrops in the vicinity of the California State University Channel Islands campus. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: The cushion lichen, Niebla ceruchoides, appears to provide a nursery habitat for seed capture and germination for D. verityi (Riefner 1992) (see cover photo). The Dudleya species which have small yellow to orange flowers (including D. verityi) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds (Levin and Mulroy 1985, Aigner 2004). (USFWS, 2009)

**Breeding Season**

Adult: May to June (USFWS, 2009)

**Reproduction Narrative**

Adult: Dudleya verityi blooms in late spring (May-June) (California Native Plant Society (CNPS) 2008) and has floral stalks 5 to 15 cm (2.0 to 5.9 in) tall with lemon-yellow corollas and petal tips recurved to 90 degrees (Service 1999). The cushion lichen, Niebla ceruchoides, appears to provide a nursery habitat for seed capture and germination for D. verityi (Riefner 1992). The Dudleya species which have small yellow to orange flowers (including D. verityi) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds (Levin and Mulroy 1985, Aigner 2004). (USFWS, 2009)

**Habitat Type**

Adult: Terrestrial (USFWS, 2009)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Hardwood

**Geographic or Habitat Restraints or Barriers**

Adult: Based on CNDDB (2008) records and recently mapped coordinates onto Google Earth (2008), known occurrences of Dudleya verityi prefer elevations ranging from 60 to 350 m (200 to 1150 ft) Dudleya verityi prefers slopes ranging from 20 to 90 degrees, and most commonly with north-facing exposures (CNDDB 2008, Sagar 2008). (USFWS, 2009)

**Spatial Arrangements of the Population**

Adult: Scattered (USFWS, 2009)

**Environmental Specificity**

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

**Site Fidelity**

Adult: High (inferred from USFWS, 2009)

**Dependency on Other Individuals or Species for Habitat**

Adult: There is evidence that mosses and lichens aid in seed recruitment and germination by providing nutrients, moisture, substrate, and protection against snails and slugs (Riefner and Bowler 1995, Riefner et al. 2003). (USFWS, 2009)

**Habitat Narrative**

Adult: In general, Dudleya taxa typically inhabit ocean bluffs, sheer cliffs, and rock outcrops including open habitat soils that have nutrient poor substrates and little vegetation (Riefner et al. 2003). This species is highly localized in its distribution, occurring exclusively in thin-soiled substrate over rocky outcrops derived from the Miocene Conejo volcanics (Service 1999). Based on CNDDB (2008) records and recently mapped coordinates onto Google Earth (2008), known occurrences of Dudleya verityi prefer elevations ranging from 60 to 350 meters (200 to 1150 feet). Dudleya verityi prefers slopes ranging from 20 to 90 degrees, and most commonly with north-facing exposures (CNDDB 2008, Sagar 2008). The entire distribution of the species is scattered over a 6.4-km (4-mi) stretch of land along the northern slope of Conejo Mountain and on north-facing volcanic outcrops in the vicinity of the California State University Channel Islands campus. (USFWS, 2009)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Long term trends indicate a decline of <50% to relatively stable, while short-term trends suggest declines of 10-30% (NatureServe, 2015)

**Number of Populations:**

8 (USFWS, 2023)

**Population Size:**

Thousands (USFWS, 2023)

**Adaptability:**

Low (inferred from USFWS, 2009)

**Population Narrative:**

As a result of 2003 surveys (Sagar 2008) which reported an additional six occurrences, the number of occurrences is now currently at nine (CNDDB 2008, Sagar 2008). Due to its location in a highly developable area and a very narrow distribution short-term trends indicate a decline of 10-30% and long term trends of relatively stable to declines less than 50% (NatureServe, 2015). (USFWS, 2009; NatureServe, 2015). At the time of listing in 1997 (Service 1997), there were 3 known occurrences of D. verityi. This number is now increased to a total of 8 CNDDB Element Occurrences ([EO] Table 1, CDFW 2023), and one possible unassigned occurrence (Dorsey et al. 2013, p. 61). An EO is a group of plants separated by at least 400 meters (1/4 mi) from the closest group of plants of the same species. The increase in the number of occurrences since listing was recognized in the Service 2009 5- year review and in Dorsey et al. 2013, but at the time of these publications CNDDB EO numbers had not yet been assigned to all of them. This resulted in different identification numbers being used for the same occurrences among the publications that differ somewhat from the current CNDDB EO numbers. We cross-walked the identification numbers in Table 1 above. Eight of nine occurrences are known since at least 2003, and it is unlikely that additional occurrences will be found beyond the small, known geographic range of the species. We presume that all the occurrences are currently extant (CDFW 2023). More than half of the occurrences are partially or fully on private land, with limited or no access for surveys. Several of the occurrences are relatively close to adjacent occurrences and may be merged in the future, particularly EO# 1 and EO# 4, and EO# 3 and the unassigned occurrence also on Conejo Mountain. The areas between these occurrences are on private land and not available for survey. EO# 1 has a range of hybrids between D. verityi and D. lanceolata as well as pure D. verityi (Guilliams and Hasenstab-Lehman 2020, pp. 34-36). EO# 5 may contain only hybrid plants between the two species (Dorsey et al. 2013, pp. 58 and 65), but no genetic analysis of the EO# 5 occurrence has been conducted. We discuss hybridization further in the threats section below (USFWS, 2023). Abundance: Information about total population size for D. verityi was not given when we listed the species (Service 1997). Most of the occurrences and individuals are at least partially on private land, and have limited or no accessibility for surveys. Botanists surveyed at least parts of most of the occurrences in 2003, and estimated that the species had a total of approximately 15,000 individuals (Table 2). This is the most comprehensive data regarding D. verityi abundance available. Three occurrences (EO# 1, EO# 2, and EO# 6) had population surveys in the same three years2003, 2010, and 2021. It is unknown how similar survey efforts were between years. Each of these occurrences had decreasing numbers of plants from 2003 to 2010, with total numbers of 13,450 in 2003 and 3,479 in 2010 (Table 2). These occurrences were also visited immediately after the 2013 Springs Fire burned over all occurrences of the species, causing severe mortality estimated at over 90% of the known individuals of the species (CNDDB 2023). The 2013 postfire count was described as a “brief visit”, and there was a total of only about 10 plants visible among these three occurrences (Dorsey et al. 2013, p. 66). Numbers of plants were not given for each separate occurrence, and CNDDB (2023, not included in Table 2 below) reports this total only as 11-50 plants for EO# 2, without giving numbers for EO# 1 or EO# 6. It is likely that at that time there were individuals which had the leaves burned off and were still alive but undetected. Botanists conducted a 2021 survey of the same three occurrences (EO# 1, EO# 2, and EO# 6), and found a total of 1,016 plants. Because of the decrease in numbers between 2003 and 2010 and the continued effects of the Springs Fire, all occurrences are characterized by CNDDB as decreasing (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Rock quarry (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, the lower slopes of Conejo Mountain near occurrence number 2 have been the site for quarrying of construction-grade rock. This land is zoned by the County of Ventura for mineral extraction and there are abandoned, active, and proposed quarry operations within the distribution of Dudleya verityi (Service 1997, 1999). However, the quarrying near occurrence number 2 remains as the only current quarry operation within the distribution of D. verityi, and even though we are not aware of any individuals of D. verityi that have been affected by these actions, the current quarry operation has violated some of their county permit requirements and has mined beyond the permit boundaries (C. Danko, Ventura County Planning Division, pers. comm. 2009). In addition, the quarry operation, once back in compliance with county requirements, may request to expand its operation. Therefore, the activities and the effects of this quarry to D. verityi or its habitat remain unclear and therefore continue to be a threat. (USFWS, 2009)

**Stressor:** Development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the current time, habitat encroachment from new or existing development activities surrounding several of the known Dudleya verityi occurrences continues to be a threat to the species and its habitat. For the most part, D. verityi and associated habitat is located in areas where impacts from development itself may not directly affect the species or its habitat. However, the associated human impacts to the land (e.g., hiking, mountain biking) in these areas adjacent to new or existing developments could result in D. verityi and associated lichen communities to be trampled and/or dislodged. Additionally, erosion from such activities may

cause changes in the substrate which may change the microhabitat necessary for the lichen communities to persist. (USFWS, 2009)

**Stressor:** Collection (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An incident of vandalism of chalk dudleya (Dudleya pulverulenta) occurred near a public access location in Topanga Canyon, California in 1999, illustrating that collection of Dudleya species continues to be a threat to members of this genus (Farris 1999). Even though we are unaware of any collection of Dudleya verityi, occurrence number 1, 5, and 7 are especially prone to collection given the ease of accessibility and proximity to existing development and roads. (USFWS, 2009)

**Stressor:** Caterpillar predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Damage from caterpillars eating the inside of the stems of plants within the Dudleya genus has been reported in many locations. These hollow roots and stems were first noticed in some Dudleya individuals as early as 1990 and have been reported as far south as the considerably isolated Isla Zapato in Mexico, leading to speculation that it is a native caterpillar that is responsible for the damage (McCabe 2008b). (USFWS, 2009)

**Stressor:** Air quality (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Air pollution impacts to coastal sage scrub have been documented in the Santa Monica Mountains as a threat to the viability and functioning of the habitat (O'Leary 1990). The diverse lichen flora associated with D. verityi contains species that are considered rare and disappearing from southern California (Riefner 1992). The cushion lichen (Niebla ceruchoides) appears to provide a nursery habitat for seed capture and germination for D. verityi (Riefner 1992). The population of Niebla on Conejo Mountain is the largest on the mainland (it is also known from the California Channel Islands). Lichens are sensitive to air pollutants and have been eliminated from many areas during the past century (Hale 1983). Studies in California have shown a strong correlation between the increases in smog and the loss of the regional lichen flora (Sigal and Nash 1982). With Ventura County's improvements in air quality, air pollution is not the threat it was at the time of listing. However, until studies have been performed to determine the levels of smog that would impair the ability for the cushion lichen, Niebla ceruchoides, to persist, air quality may continue to be a threat to D. verityi. (USFWS, 2009)

**Stressor:** Fire suppression, fuel modification, wildfire survivability, and invasive species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** At the time of listing in 1997, we discussed general threats to several species within the Dudleya genus, including the effects of fire (Service 1997). Natural fire regimes of these areas have been affected, consequently having drastic effects on the grassland, coastal sage scrub, chaparral, and oak woodland ecosystems and the species that reside there (Keeley et al. 1999). In some cases, D. verityi is threatened by direct removal during fuel modification and fire-break efforts that occur in the vicinity of the habitat for this species due to the large number of residences and buildings that exist in close proximity to the existing distribution of this species (Service 1997, 1999; Sagar 2008). Additionally, fire that reduces or eliminates the lichen community could dramatically reduce the extent and number of populations of D. verityi. Lichens grow very slowly and persist for long periods of time (Hale 1983). The population structure of D. verityi depends on mature lichen individuals (Service 1999). Therefore, an extremely hot fire could remove the necessary substrate for the species to germinate and would modify D. verityi habitat for an uncertain period of time. Although the plants probably have the ability to survive small, low-intensity fire, there is a high probability that the plants may not survive a larger, high intensity fire. Increased fire suppression over the last century in a large portion of southern California increases the chance of having these larger, more intense fires (Keeley et al. 1999) and thus high intensity fires may pose a threat to the species. (USFWS, 2009)

**Stressor:** Stochastic extinction (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, we noted that due to the limited number of individuals and the restricted range of Dudleya verityi, this species is under threat of extinction from naturally occurring events, such as fire, drought, disease, or rock slides (Service 1997). As a result of the number of individuals and range of D. verityi, the genetic viability and thus resilience of the species to human-caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The Santa Monica Mountains and Simi Hills are expected to increase in diversity becoming potential future refugia for some species (Loarie et al. 2008). Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors, such as low numbers of individuals, will affect Dudleya verityi, small ranged species such as D. verityi are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 5C

**Delisting Criteria:**
1. All the current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)

2. All the current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

**Recovery Actions:**
- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Survey historic locations and other potential habitat where the six plant species may occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)
- Conduct new, up-to-date extensive population survey of existing and potential habitat sites. Potential partners include the National Park Service (Santa Monica Mountains Recreation Area), California State Parks, and California State University, Channel Islands. (USFWS, 2009)
- Develop and implement monitoring and adaptive management plans for known existing occurrences. Monitoring should follow Sahatjian's (2008) monitoring methodology. Update and expand knowledge of species life history and specific habitat requirements. (USFWS, 2009)
- Work on public outreach and education with private land owners in the area; develop incentives aimed at conservation of the species. Seek input from public and other stakeholders on the management and preservation of the species. Cooperative agreements and coordinated planning and management efforts could assist in conservation efforts. (USFWS, 2009)
- Work closely with agencies to implement a species monitoring and public outreach program, in addition to implementing new conservation measures for the species (e.g., fencing off certain areas, etc.) and preserving additional potential habitat for the species. (USFWS, 2009)
- Work with county planning departments to develop a species conservation plan; if development does occur, onsite protection should be required. (USFWS, 2009)
- Investigate air quality impacts on cushion lichen, Niebla ceruchoides. (USFWS, 2009)
- Investigate Dudleya verityi (and suspected hybrids) growing and reproducing on the clay tile roofs at California State University Channel Islands campus near occurrence number 5 to determine whether these plants are in fact D. verityi, and not hybrids. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue genetic and morphometric analyses to determine the extent of hybridization with other Dudleya species, and deposit voucher specimens of the variation at all occurrences in herbaria. 2. Conduct thorough surveys within all known occurrences and areas of suitable habitat. 3. Conduct surveys to determine if there are additional plants in areas between the currently mapped occurrences, and if occurrences can be merged. 4. Develop and implement a monitoring plan for all occurrences. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 5. Work with public and private entities to gain access to occurrences, prevent damage to plants, and raise public awareness to support appropriate conservation measures. 6. Update and expand knowledge of the species' life history and specific habitat requirements, especially the relationship to lichens that are important for recruitment. Continue the work to enhance lichen abundance that is currently being performed so that successful outplanting to the field can occur, which would help increase overall population abundance and resiliency against severe wildfires. 7. Continue the recovery actions of supplemental watering and lichen transplantation until the pre-Springs Fire lichen habitat is reestablished. 8. Increase the number of D. verityi accessions in conservation seed banks, so that all known occurrences are represented in the collections. (USFWS, 2023).

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# SPECIES ACCOUNT: *Echinacea laevigata* (Smooth coneflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/8/1992; Southeast Region (R4) (USFWS, 2015). Reclassified to Threatened on August 5, 2022

**Physical Description**

A rhizomatous perennial herb, which grows to a height of about 1.5 m, with smooth stems, few leaves and pink to purplish flowers. This species flowers from May to mid-July and fruits from late June to September (Gaddy 1991) (NatureServe, 2015).

**Taxonomy**

It belongs to the aster family (Asteraceae) was first described in 1903, under the name Brauneria, by Boynton and Beadle from material collected in South Carolina in 1888; it was transferred to the genus Echinacea in 1929 (Small 1933, McGregor 1968) (USFWS, 1995).

**Historical Range**

The reported historical range of smooth coneflower included Pennsylvania, Maryland, Virginia, North Carolina, South Carolina. Georgia, Alabama. and Arkansas (USFWS, 1995).

**Current Range**

Current range: Georgia, South Carolina, North Carolina, Virginia. Reports from Alabama and Arkansas are believed to have been misidentifications (Gaddy 1991); also an apparent false report from Maryland (NatureServe, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, vegetative (USFWS, 1995)

**Breeding Season**

Adult: May through July (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Insect pollinators; bare soil that is rich in magnesium and/or calcium; disturbance (USFWS, 1995)

**Reproduction Narrative**

Adult: Flowering occurs May through July; fruiting occurs June to October. Seldom produces viable seeds. Rhizomatous/Cormophyte (NatureServe, 2015). Gaddy (1991) stated that reproduction was apparently only by sexual means and that no vegetative reproduction had been observed. However, vegetative reproduction has been reported from the Chattahoochee

National Forest in Georgia (Robert Joslin, U.S. Forest Service, personal communication, 1994) and from the Sumter National Forest in South Carolina (Lonnette Edwards, U.S. Forest Service, personal communication. 1995). Pollinators for this species are unknown; however, Edwards and Madsen (1993) have documented preliminary list of insect visitors to South Carolina populations of smooth coneflower (see Appendix A). Smooth coneflower appears to need bare soil that is rich in magnesium and/or calcium for seedling germination and growth. Some form of disturbance (such as fire) is also essential (USFWS, 1995)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Prairie, oak-savannas, cedar barrens, limestone bluffs (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full or partial sun (NatureServe, 2015); periodic fire (USFWS, 1995)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Formerly, a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires. Now, primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. Usually found in areas with magnesium and calcium-rich soils. Requires full or partial sun. Associated species include: Juniperus virginiana and Eryngium yuccifolium. This species is disturbance dependent (NatureServe, 2015). Smooth coneflower occurs in community types described by Schafale and Weakley (1990) as xeric hardpan forests and diabase glades or in Virginia dolomite woodlands or glades as described by Rawinski (1994). Optimal sites for smooth coneflower are characterized by abundant sunlight and little competition in the herbaceous layer (Gaddy 1991). Natural fires, as well as large herbivores, are part of the history of the vegetation in this species' range (USFWS, 1995).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are probably dispersed by seed-eating birds or small mammals (USFWS, 1995).

***Population Information and Trends***

**Population Trends:**

Decline of 30-70% (NatureServe, 2015)

**Species Trends:**

Stable (USFWS, 2011)

**Number of Populations:**

68 (USFWS, 2011)

**Population Size:**

2500 - 100,000 individuals (NatureServe, 2015)

**Population Narrative:**

Remaining populations appear to be small in numbers which may result in low genetic diversity. Since the species' discovery, more than 2/3rds of the historical populations have been lost. Known from 61 populations in 8 states. However, when it was listed, it was known from fewer than 25 sites in 4 states. This species has experienced a long-term decline of 30-70%. A site in North Carolina is probably the largest, with an estimated 2000 individuals. Total estimated population size is 2,500 - 100,000 individuals. Species is limited to 4 states, 10 counties and about 20 populations in a narrow band from Georgia through the Carolinas to Virginia. There are a few restored populations in Georgia and South Carolina. (NatureServe, 2015). Based on survey information gathered at individual populations throughout the range of the species, it appears that the Echinacea laevigata is stable. Peters et al. (2009) found that the species displays a relatively high level of diversity based on analyses across the range of populations. A total of 68 populations are considered extant while 32 populations are believed to be extirpated or historical (USFWS, 2011).

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Echinacea laevigata is threatened range-wide by the suppression of fire and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis. Echinacea laevigata also is threatened by timber operations. Sites located within utility rights of-way are threatened by herbicide use and/or mowing during critical growth periods. The destruction of habitat, resulting from development or land conversion also threatens this species, but to a lesser degree than the factors listed above. The invasive plant, Pueraria lobata (kudzu), occurs at one Echinacea laevigata population in SC. Lespedeza cuneata (Sericea lespedeza) is problematic at some roadside locations in NC (USFWS, 2011).

**Stressor:** Longhorn beetle (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The non-native longhorn beetle (Hemierana marginata) has been identified at some Echinacea laevigata populations in NC. This beetle chews into the flowering stems causing flowers to die before they produce viable seeds. The insect also may burrow into the base of the plant killing the plant (Laura Gadd, NC Plant Conservation Program, Raleigh, NC, pers. comm.) (USFWS, 2011).

***Recovery***

**Reclassification Criteria:**

1. 12 geographically distinct, self-sustaining populations are protected across the species' range, including some populations in at least two counties in VA, two counties in NC and two counties in SC and one county in GA (USFWS, 2011).

2. Managers have been designated for each population (USFWS, 2011).

3. Management plans have been developed and implemented (USFWS, 2011).

4. Populations have been maintained at stable or increasing levels for five years (USFWS, 2011).

Recovery Priority Number: 5

**Delisting Criteria:**
1. At least 15 geographically distinct, self-sustaining populations are protected in at least two counties in VA, two counties in NC, two counties in SC and one county in Georgia (GA) (USFWS, 2011).

2. Management plans have been developed and implemented for each site (USFWS, 2011).

3. Populations (as measured by number of adult plants) have been stable or increasing for 10 years (USFWS, 2011).

4. Permanent conservation ownership and management of at least 10 populations are assured by legally binding instruments (USFWS, 2011).

**Recovery Actions:**
- Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1995).
- Implement protective management for extant populations (USFWS, 1995).
- Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range (USFWS, 1995).
- Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.) (USFWS, 1995).
- Monitor existing populations (USFWS, 1995).
- Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs (USFWS, 1995).
- Revisit known populations that have not been visited in the past three years in order to monitor the population size, habitat conditions and to document any potential threats to the viability of each site; discuss conservation options with landowners and managers where appropriate; report findings to the appropriate NHP (USFWS, 2011).
- Search for additional populations in appropriate habitat (USFWS, 2011).
- Identify those populations/subpopulations that will contribute toward long term recovery and determine their status (increasing, stable or decreasing) (USFWS, 2011).
- Prioritize protection of unprotected sites that are critical for recovery and protect them (USFWS, 2011).
- Develop conservation agreements with applicable landowners to ensure recovery objectives are met (USFWS, 2011).

- Determine which sites have management plans and how they are being implemented and develop and implement management plans for the remaining sites that are deemed to be critical to the recovery of the species (USFWS, 2011).
- Develop monitoring protocols and initiate long-term population monitoring that will demonstrate if a site is stable or not (USFWS, 2011).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2011).
- Conduct further genetic analysis of populations not included in the research by Peters, et al (2009) (USFWS, 2011).
- Organize a meeting of land managers, researchers and other interested parties to discuss the recovery of this species (USFWS, 2011).
- Collect seeds and develop propagation protocols according to Center for Plant Conservation guidelines (USFWS, 2011).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2011).
- Secure funding to accomplish the actions listed above (USFWS, 2011).

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# SPECIES ACCOUNT: *Echinocactus horizonthalonius var. nicholii* (Nichol's Turk's head cactus)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** NTHC

**Listing Status:** Endangered; 11/28/1979; Southwest Region (R2)

**Physical Description**

The NTHC is a small, blue-green to gray-green, barrel cactus that is globose, becoming more columnar as it grows. Large individuals range in height from 41 to 51 cm (16 to 20 inches) tall and range in diameter from 13 to 20 cm (5 to 8 inches) wide. Individuals are single-stemmed with 8 ribs that spiral around the base to the apex. Each areole has three central spines, one black that curves downwards and two red or basally gray that curve upwards, and 5 radial spines that tend to be black or partially gray. Flowers are 4 to 7 cm (1.5 to 2.7 inches) in diameter when fully opened (Chamberland 1995; Turner et al. 1995). One to five bright pink fruits are produced in May and June (Benson 1982) and are covered with wooly, white hairs at the apex of the stem, becoming dry with maturity. (USFWS, 2009)

**Taxonomy**

Baker (2007, 2009) is conducting a multivariate analysis to compare the degree of morphological variation of stem characters within populations of variety nicholii to populations within E. horizonthalonius throughout its known range to determine if these characters are significantly different to the full suite of characters. Baker's results suggest that there are three distinct varieties within the species E. horizonthalonius: variety nicholii in the Sonoran Desert population, variety horizonthalonius in the Chihuahuan Desert, and an unnamed variety in San Luis Potosí, Mexico. However, more populations need to be measured in order for the results to be conclusive (M. Baker, pers. comm. 2009) (USFWS, 2009).

**Historical Range**

It is endemic to the Sonoran Desert (Pima and Pinal Counties, , Arizona, and Sonora, Mexico). (USFWS, 2009)

**Current Range**

Populations occur in the Waterman Mountains and Koht Kohl Hills in Pima County, Arizona; the Vekol Mountains including those near the vicinity of the Vekol Mine in Pinal County, Arizona; and a population in the Sierra del Viejo Mountains in Sonora, Mexico (USFWS, 2009). The NTHC occurs in isolated mountain ranges that extend from southcentral Arizona in Pima and Pinal Counties to a disjunct location in Sonora, Mexico. The plant is found almost entirely on Horquilla limestone. (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: Extremely slow-growing; takes 10 years to reach a height of 2 inches (NatureServe, 2015).

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2009)

**Lifespan**

Adult: 35 - 95 years (USFWS, 2009).

**Breeding Season**

Adult: April - July (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Soil seed bank (USFWS, 2009)

**Reproduction Narrative**

Adult: Flowering occurs during mid-April to July, with 90 percent of blooms occurring in June (USFWS 1986). One to five bright pink fruits are produced in May and June (Benson 1982). The NTHC is self-incompatible, requiring pollen from another plant for pollination. Individual lifespan is estimated between 35 and 95 years (USFWS 1986; Schmalzel and Francisco 2000). Each fruit generally contain less than 100 seeds (K. Rice, pers. comm. 2008). The Schmalzel and Francisco (2000) study found that individuals reach maturity (i.e. bloom for the first time) at 2 cm (0.78 inches) tall and 8 cm (3.2 inches) wide. Preliminary studies examining population age-structure suggest that an immature cactus takes 11 to 13 years to reach a diameter of 2 cm (0.78 inches). Seeds are incorporated into a soil seed bank until favorable conditions for germination are present (Ecker 1991; Rojas-Aréchiga and Vázquez-Yanes 2000; Godinez-Alvarez et al. 2003; notes from S. Brack, Mesa Garden, courtesy of Desert Botanical Garden files) (USFWS, 2009).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Sonoran desert scrub (USFWS, 2009; NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 730 - 1,250 m elevation (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2009; see dispersal/migration narrative)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Occurs in Sonoran desert scrub on dissected alluvial fans at the foot of limestone mountains, and on inclined terraces and saddles on limestone mountain sides at 730 -1,250 m. It has been found to grow almost exclusively on Pennsylvania-aged Horquilla limestone (USFWS 2009; NatureServe, 2015). The environmental specificity is narrow (specialist or community with key requirements common) (NatureServe, 2015). It occurs on 0 - 30 percent slopes with a north, west, and south-facing exposure. Grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or shouldered next to rocks on steep slopes and within limestone outcrops. Occurs in Parkinsonia microphylla scrub with Ambrosia deltoidea, Carnegiea gigantea, Cylindropuntia acanthocarpa, Encelia farinosa, Fouquieria splendens, Krameria grayi, and Opuntia phaeacantha (Baker 2007). Other dominant associated plant species include Larrea tridentata, Ambrosia deltoidea, Krameria grayi, and Opuntia sp. (USFWS 1986; NatureServe, 2015).

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: Seedlings often establish around the base of the "mother" plant and can give the appearance of small clumps (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019)

**Number of Populations:**

4-5 (USFWS, 2021)

**Population Size:**

<1,300 (USFWS, 2021)

**Population Narrative:**

As of 2020, there are thought to be fewer than 1,300 total individuals (an estimated 1,024 live and 288 dead), most of which occur in the Waterman Mountains of Pima County Arizona. The status of NTHC on the Tohono O'odham Nation is uncertain. Despite surveys since the 1980s and continuing periodically through 2020, no new populations have been located outside of the four historical areas (the Waterman Mountains and Koht Kohl Hills in Pima County, Arizona; the Vekol Mountains in Pinal County, Arizona; and the Sierra del Viejo Mountains in Sonora, Mexico). A potential fifth population of 83 plants that morphologically resemble the NTHC occur in central Sonora (Van Devender and Reina-Guerrero 2012, entire). Their taxonomic status remains uncertain and until verified, the population is not considered the listed entity (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2019)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Habitat desctruction to the Waterman Mountains population is no longer adversely affecting var. nicholii. As of 2018, the BLM has completed most of the recovery actions from the Recovery Plan. The establishment of IFNM with the signing of the Presidential Proclamation, permanently protects natural resources within the 906.5 ha (2,240 ac) encompassing var. nicholii's habitat. In accordance with the proclamation, IFNM is withdrawn from all forms of mineral extraction and recreational off-road vehicles (Service 2009, BLM 2011, 2013). In implementing recovery actions, BLM has acquired 148.9 ha (368 ac) out of 222.5 ha (550 ac) of patented land held by a private owner within occupied habitat and continues to pursue acquisition of remaining private acreages (BLM 2011; D. Tersey BLM, pers. comm. 2018). (USFWS, 2019)

**Stressor:** Herbivory (USFWs, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Recovery Plan stated that moderate levels of grazing did not appear to affect the var. nicholii because cows seem to avoid stepping on the plants (Service 1986). Moderate grazing continues throughout var. nicholii's habitat (Service 2012). During the summer months, cattle may congregate under large trees for shade in dense patches of var. nicholii and disturb its habitat (K. Robertson, FWS, pers. obs., 2018). We have little evidence (observed or documented) of cows stepping on the cactus or damaging its tissue. BLM manages the Agua Dulce Grazing Allotment to promote var. nicholii conservation. Livestock waters are currently located next to existing roads, but BLM will move or replace those that cause habitat impacts. BLM will place any future water developments in locations to move cattle outside of occupied areas with the intent to reduce or minimize any impacts (BLM 2013; Service 2012). However, any potential effects from livestock grazing, as well as bighorn sheep and other small mammals have not been fully evaluated and should be considered in a thorough threats assessment. (USFWS, 2019)

**Stressor:** Climate change (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is considered a threat to var. nicholii due to effects from hotter temperatures and increased aridity (Service 2009). Climate change has resulted in some species shifting their range to higher elevation or higher latitude (Hannah et al., 2005; Chen et al., 2011). For southwestern plants, scientists are finding migration may occur in all directions depending on the species' ability to adapt, and having available, connected habitat (Stills et al., 2015; Krause and Pennington 2012; Notaro et al., 2012). Variety nicholii grows on mountain slopes that could presumably support more plants in the future if they remain cooler and soils retain more moisture than those on the valley floor. Alternatively, as temperatures and aridity increase, these exposed areas may become hotter, drier and ultimately unsuitable in the future. With the limiting presence of Horquilla limestone on a few mountain ranges, changes in the suitability and amount of available habitat for the taxon could cause dramatic reductions in its range. Gaining a better understanding of its adaptive capacity and conserving the distinct geographic areas where it occurs will allow opportunities for the taxon to endure into the future. (USFWS, 2019)

**Stressor:** Invasive plant species (USFWS, 2019)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the 5-year Status Review, we identified the spread of invasive grass, Cenchrus ciliaris as a significant threat to var. nicholii habitat. Cenchrus ciliaris had expanded into a 7.2 ha (18 ac) area on the north side of Waterman Mountains, including a location near hundreds of var. nicholii increasing the fire risk (Service 2009). There have been recurrent efforts to control Cenchrus ciliaris by manual removal through various volunteer organizations (2005-2009) and BLM contracted annual herbicide sprayings (2008-2009). In 2010, the BLM organized a mechanical reshaping and contouring of the area that was followed by restoration efforts through 2012 (J. Scheuring, Friends of Ironwood Forest, pers. comm., 2013). Cenchrus ciliaris has been effectively brought under control through continued removal and spot treatment which eliminated its threat to nearby var. nicholii. In 2016, several var. nicholii seedlings were found growing in the restoration area. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
The criterion for downlisting to threatened status is permanent protection of 75 percent of the known habitat according to the steps outlined in the Recovery Plan. (USFWS, 1986)

Recovery Priority Number: 3

**Delisting Criteria:**
1. Conserve and protect all existing var. nicholii individuals and habitat for their pollinators (approximately a 600 meter (0.37 mi) radius around each plant) in three or more extant populations through land protection, land management actions, and restoration techniques (i.e., actions that enhance habitat quality, support increased germination, and establishment). Each var. nicholii population must have available habitat of sufficient quality and size for natural population dynamics and long-term expansion, to support a viable seed bank, as well as, habitat for pollinators, allowing pollen exchange within populations. Variety nicholii habitat is defined as areas that contain the appropriate geology, elevation, soil type, Sonoran Desert native plants and trees, native pollinators, with minimal ground disturbance and limited non-native invasive grass species. (USFWS, 2019)

2. Each var. nicholii population must be self-sustaining, with annual recruitment exceeding mortality over any 20 years of a 30-year period. Long-term monitoring every 3–5 years demonstrates that the annual total estimated population size among three or more extant populations is maintained at or greater than 3,700 individuals for a minimum of 20 years over a 30-year survey period. Threats must be managed so that populations can be maintained at target levels (a minimum of 3,700 total individuals) for a minimum of 20 years over the 30year period. Expected yearly fluctuations in plant abundance due to changes in precipitation, fire, or other causes, may result in two monitoring events during the time period that does not meet these targets. (USFWS, 2019)

3. Develop a long-term ex-situ (off-site) var. nicholii conservation program that includes maintenance of seeds for conservation and recovery at seed storage facilities, captive propagation, germination trials, guidelines for supplementing natural populations, and

postintroduction monitoring that demonstrates the introduced var. nicholii are fully functioning in their environment, including flowering, seed production, and survival. (USFWS, 2019)

**Recovery Actions:**

- Maintain, protect, and enhance natural populations. It is important and crucial to the preservation of the Nichol Turk's head cactus to protect populations in the wild. To do this, a continuing program of law enforcement, monitoring, and management must be implemented and coordinated among Federal agencies, the State of Arizona, and private individuals or organizations. (USFWS, 1986)
- Study populations in their natural habitat at existing sites. An in-depth knowledge of the plant's ecology and biology is needed to understand its habitat requirements. With this information, sound management decisions can be made and implemented to sustain healthy, natural populations. The use of a well documented and accessible living collection could provide a source of material for these types of studies. (USFWS, 1986)
- Develop a comprehensive trade management plan (CTMP) for all cacti. Prior to development of trade management strategies, studies are necessary to determine what species are in the trade, the overall trend of trade in listed cacti, the feasibility of reducing the collecting pressure on the wild populations by promoting a commercial artificial propagation program, and to determine strategies for effective implementation of law enforcement responsibilities of ESA, CITES, Lacey Act, and State laws. These studies should be national in scope and address all cacti. Completion of subtasks 31 through 34 will result in development of an FWS policy on the cactus trade problem and will allow the drafting of a CTMP. (USFWS, 1986)
- Develop public awareness, appreciation, and support for the preservation of the Nichol Turk's head cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of the foregoing recovery measures. Public interest groups, especially local ones such as botanical gardens native plant societies, cactus societies, and The Nature Conservancy chapters need to be involved. The visibility of their support can be instrumental in shaping public opinion. Specific strategies would include lectures, pamphlets, letters, etc., concerning conservation of threatened and endangered plant species. (USFWS, 1986)
- Recommended Action from 2009 5-Year Review: The 1986 NTHC Recovery Plan should be revised to incorporate new information that has been gathered since it was finalized. The recovery criteria should be revised to address newly identified threats to the subspecies. Criteria for delisting should be established. Threats should be discussed relative to the five-factor analysis regarding their impact to the subspecies and its habitat (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Establish a systematic monitoring protocol to more effectively evaluate the status of the subspecies across its known range. Expand the area being monitored to include a larger sample size that is more representative of the Waterman Mountains population. Monitoring should be designed to establish long-term population trends and investigate effects of climate change (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Studies should be conducted to obtain the quantified data in order to support the recovery criteria using the best scientific and commercial data available. Studies should focus on: ecological factors that influence distribution, density-dependence issues, resource requirements for survival, seedling establishment and dispersal, pollination, demographic trends, population biology, and the amount and condition of suitable habitat (USFWS, 2009).

- Recommended Action from 2009 5-Year Review: Evaluate the genetics of this subspecies to better understand its evolutionary history and relationship to E. horizonthalonius, and to assess genetic variation within and between the populations. This information would provide a better understanding of its historical range and taxonomic classification (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Establish a cooperative partnership with OVIS and develop a conservation agreement to survey and (if found) study the cactus in the Sierra del Viejo Mountains in Sonora, Mexico (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: The USFWS should coordinate cooperative agreements with the Tohono O'odham Nation and ensure that partnerships continue to help protect and conserve the cactus on Tribal land (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: The USFWS should coordinate and establish cooperative partnerships with private landowners to implement conservation of the cactus on their land (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Our recommended future actions from the 2009 5-year Status Review remain relevant, and we provide those below with some modifications. We also recommend additional actions to improve our understanding of climatic changes on the status of the NTHC and address data needs to improve long-term species management decisions. 1. Understand trends in survival and mortality of individuals and populations. Cactus species are known to have recruitment events following sufficient precipitation; however, long-term monitoring of the NTHC demonstrates that its response to precipitation and higher temperatures are not as straightforward. With the persistent drought, it is important to continue to investigate demographic trends in order to tease out how mortality rates increase with variable climate patterns. 2. Expand the monitoring area to include a larger sample size that is representative of all populations. Locate demographic plots at sites differing in aspect and slope, and better reflect the representation and redundancy of the cactus. Explore other types of sampling methods (distant sampling transects) to compare information about demographics and changes in habitat. 3. Examine habitat suitability, including the taxon's ability to persist in all populations. Results would guide management decisions on important areas for enhancement or future recovery actions for the cactus' persistence in the future. 4. Conduct germination studies and captive propagation to support future re-establishment of plants in their native habitat, in the event we need to supplement the population or create refugia populations. 5. Evaluate the genetics of this subspecies to better understand its evolutionary history and relationship to E. horizonthalonius, and to assess genetic variation within and between the populations. This information would provide a better understanding of its historical range and taxonomic classification. 6. Invest and support studies examining other potential stressors (invasive grasses, herbivory, disease, and habitat disturbance) to the cactus. For example, placement of cameras and / or fencing could improve our understanding of the roll of herbivores in cactus decline. 7. The Service should continue to enhance and maintain our partnership with the Tohono O'odham Nation to cooperatively achieve long-term conservation of the NTHC on Tribal land. 8. Establish a cooperative partnership with private landowners in Sonora, Mexico that enables information exchange and advances conservation efforts to document, study, and protect the cactus. (USFWS, 2021)

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# SPECIES ACCOUNT: *Echinocereus reichenbachii var. albertii* (Black lace cactus)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** BLC

**Listing Status:** Endangered; 11/28/1979; Southwest Region (Region 2)

**Physical Description**

A spin succulent with solitary stems (or sometimes 5-12), the larger green, cylindroid, 7.5 - 15 cm long, 2.5 - 5 cm diam.; ribs about 12 to 18; areoles narrowly elliptic, 1.5 mm long vertically, typically 2 - 4.5 mm apart; central spines none or 1, 2 - 3 mm long, very dark purple, much smaller than the radials, but otherwise similar to them, straight (plants from Kleberg County were found that have well developed central spines, while they are weakly developed or absent in specimens from Jim Wells and Refugio Counties); radial spines white with dark purple tips, 14 - 16 per areole, closely pectinate, 3 - 4 (6) mm long, 0.2 - 0.35 mm diam., circular in cross section; flower 5 - 7.5 cm diam., 2 - 6 cm long; areoles of floral tube with conspicuous fine wool and weak spines; sepaloids with green midribs and pink margins; petaloids pink to light purple, largest oblanceolate, 2.5 - 3.5 cm long, + 9 mm broad, short acuminate, entire; filaments pale yellow or pink, + 9 mm long; anthers yellow, 1.5 mm long, oblong; style pink, 20 - 30 mm long, 1 - 2 mm greatest diam.; stigmas 16 - 20, green + 6 mm long, broad; ovary in anthesis + 9 mm long; fruit green (with pink tinge?) with short spines and soft conspicuous, deciduous, long wool in areoles, + 15 mm long, 9 mm diam.; seeds strongly tuberculate, asymmetrical, 1.5 mm long, 1 mm broad, 0.7 mm thick (Benson, 1982) (USFWS, 1986)

**Taxonomy**

The scientific name for BLC is Echinocereus reichenbachii (Terscheck) F. Haage var. albertii L.D. Benson. This variety was described from a specimen collected in 1965 in Jim Wells County (USFWS 1987). Some disagreement exists about the taxonomy of the group of Echinocereus with large pink flowers, and there are several synonyms for BLC, including E. melanocentrus (Lowry) and E. fitchii (Britton and Rose) subspecies albertii (L. D. Benson) W. Blum and Mich. Lange (Poole et al. 2007) (Table 2). Some cacti specialists lumped the BLC variety albertii with a very similar counterpart, E. reichenbachii var. fitchii. Blum et al (1998) recognized the taxon albertii but placed it within the species fitchii as a subspecies (E. fitchii ssp albertii). Others have called it a separate subspecies (Poole et al. 2007). There are distinct morphological differences between E. reichenbachii var. albertii and E. reichenbachii var. fitchii. Echinocereus reichenbachii var. fitchii has 4-7 central spines of a brownish-red color while the variety albertii (BLC) has 0-1 central spines (except the Refugio County population that lacks a central spine) and appears more blackish in coloration (Poole et al. 2007). These two varieties are also geographically disjunct, with E. reichenbachii var. fitchii occurring in thorn shrublands atop limestone soils, calcareous sandy loams, or saline clays in Jim Hogg, Starr, Zapata, and Webb Counties, and in Mexico, while E. reichenbachii var. albertii grows on sandy soils in Refugio, Jim Wells, and Kleberg Counties (Poole et al. 2007). Even with these distinctions, Zimmerman and Parfitt (2003) did not recognize any varieties of E. reichenbachii, in part due to the interfertile nature of the taxa, and also due to pure populations not existing sympatrically (Poole et al. 2007). Poole et al. (2007) pointed out that many geographically isolated taxa have not developed genetic barriers and therefore, when placed in contact with cacti of the same origin, can cross freely. (USFWS, 2009)

**Historical Range**

The historic range extends from east-central Jim Wells County on the most southwestern edge of the range to northeastern Kleberg County near Ricardo at the most southeastern point, and up to southern Refugio County at the most northern extent. This range encompasses parts of Jim Wells, Kleberg, Nueces, San Patricio, and Refugio Counties in south Texas (USFWS, 2009).

**Current Range**

Current range is Atascosa, Jim Wells, Kleberg, McMulen, and Refugio Counties in south Texas (USFWS, 2009).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect (USFWS, 2009)

**Breeding Season**

Adult: Flowers from March through June, with peak in mid-April to early May (USFWS, 2009).

**Key Resources Needed for Breeding**

Adult: Bees and wasps have been observed visiting flowers (USFWS, 2009).

**Reproduction Narrative**

Adult: Although pollinators have not been researched, bees and wasps have been observed visiting flowers (USFWS, 2009). Species is self-incompatible (USFWS, 1986).

**Habitat Type**

Adult: Terrestrial (USFWS, 1986)

**Habitat Vegetation or Surface Water Classification**

Adult: Openings in mesquite brush occurring along streams of the coastal plain (USFWS, 1986).

**Dependencies on Specific Environmental Elements**

Adult: Sandy loam or silt soil (USFWS, 1986)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevation of 50 meters or less (USFWS, 1986)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 1986)

**Habitat Narrative**

Adult: Terrestrial species; habitat is described as openings in mesquite brush occurring along streams of the coastal plain at 50 meters or less in elevation, in sandy loam or silt soil and in both level and poorly drained or sloped and well drained (USFWS, 1986).

***Dispersal/Migration***

**Motility/Mobility**

Adult: N/A

**Dispersal/Migration Narrative**

Adult: Seeds fall to the ground or are washed down by rainfall as the seed decomposes. Seed dispersal mechanisms are thought to be unspecialized, but native ants have been observed mining BLC seeds, carrying them back to their mounds, an discarding the seeds outside of the colony. Other seed-dispersal mechanisms may include fur-bearing mammals inadvertently picking up seeds in disperse seeds through their rooting activities (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2019)

**Species Trends:**

Declining (USFWS, 2019)

**Number of Populations:**

6 natural, 1 introduced (USFWS, 2019)

**Population Size:**

Uncertain (USFWS, 2019)

**Population Narrative:**

The 5-year review (USFWS 2009) indicates that six populations of black lace cactus have been found from east-central Jim Wells County to north-east Kleberg County to Refugio County (pp. 11–13). By 2009, only two extant populations were known, in Kleberg and Refugio counties. The status of the Jim Wells population, last observed in 1989, was unknown (p. 5). All extant and historic populations occurred on privately owned land (p. 4). At the Kleberg site, 43,441 individuals were reported in 1983 and 19,250 in 1985. A large portion of the site was cleared in 1986. Since then, 13,250 individuals were reported in 1987, 1,160 in 2001, and 824 in 2002. Similarly, 82,500 individuals were reported from the Refugio site in 1987 and 1,527 in 2004. The Jim Wells population had about 16,000 individuals in one sub-population in 1985; a second subpopulation was cleared, but about 48 individuals survived. Although these population censuses did not use consistent methods, and the relative numbers of juveniles and reproductive adults was not reported, all populations have apparently declined. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction (USFWS, 1986)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is common practice in the region to clear brush tracts for cultivation for improved pasture with the planting of coastal Bermuda grass. Brush clearing has partly or completely destroyed three known populations and has recently occurred near several others. Land owners of presently known populations are apparently unaware of the cactus, so land improvements could destroy present populations without the land owners even knowing it (USFWS, 1986).

**Stressor:** Grazing by cattle (USFWS, 1986)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Grazing of natural brush tracts has a negative impact on populations. For the grazed population in Jim Wells County, it was observed that cattle trample plants in open ground with few plants surviving to maturity. The only cacti present were those protected by other vegetation (USFWS, 1986).

**Stressor:** Collection (USFWS, 1986)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Collecting is always a serious threat to any small desirable species of cactus, particularly when combined with large showy flowers as found in this species (USFWS, 1986).

**Stressor:** Predation or trampling (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Individual BLC plants have been uprooted by feral hogs and kicked over by cattle. However, no other severe disturbances caused by these mammals or other animals have been noted with the exception of the presence of red imported fire ants (RIFA). Some BLC individuals at the Refugio County site have been noted to be partially or entirely covered by mounds of RIFA. There is potential that these non-native ants could pose threats to the base or quite possibly the root system of the cacti. Also, RIFA may out-compete native ant species and potentially interfere with the role these natives play in seed dispersal. The level of threat to the continued existence of BLC due to feral hog rooting and cattle trampling is unknown, although observations at the Refugio County population site indicate that this type of impact occurs in a scattered manner (USFWS, 2009).

**Stressor:** Pesticide use to control insects (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Chemical eradication techniques used for the RIFA might also negatively affect natural pollinators of the species and/or native ants and could potentially contribute to an overall decrease in any treated BLC population (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
1. Black lace cactus is documented in 10 or more protected, viable populations, with at least three viable populations in each of three recovery units. Populations and metapopulations are delineated by unpopulated gaps of at least 1 km (0.6 mi). However, as described in Section III.a., viable populations that expand and merge with other populations may be counted as separate populations for the purpose of meeting this criterion. (USFWS, 2019)

2. Viable populations have 1,100 or more mature individuals. Mature individuals have flowered at least once or are judged capable of flowering. Population censuses should be conducted during the peak of flowering and fruiting, from mid-April through May. (USFWS, 2019)

3. Protected populations occur on lands that are legally protected and managed to conserve the region's native flora and fauna, including black lace cactus and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, publicly owned land managed for conservation purposes, and legally binding long-term management agreements with private landowners. (USFWS, 2019)

**Delisting Criteria:**
Periodic monitoring indicates that the downlisting criteria have been met and that demographic trends have subsequently remained stable or have increased over a period of 25 years. (USFWS, 2019)

**Recovery Actions:**
- Remove threats to Echinocereus reichenbachii var. albertii populations by enforcement of existing regulations and management of the habitat for protection of the variety. Because of the rarity of this variety, it should be protected from collecting by enforcement of existing regulations and its habitat should be managed to ensure the continued existence of self-sustaining populations. (USFWS, 1986)
- Initiate studies on the ecology and population biology of the black lace cactus. In-depth knowledge of the population biology and ecology of the black lace cactus is needed. Some of this information may be critical to future management of the variety. (USFWS, 1986)
- Determine the genetic relationships among the three populations and between Echinocereus reichenbachii var. albertii and other closely related taxa. Knowing the level of classification of E. reichenbachii var. albertii is not so important as understanding its relationship to its closest relatives. Reliable characteristics that can be used to identify flowering or sterile specimens are essential for enforcement of trade regulations. Determination of the distinctness of the taxon is also imperative since considerable expenditures may be necessary to protect and maintain it in perpetuity. Genetic studies using isozymes and/or flavanoids combined with a thorough morphological analysis can provide evidence on the distinctness or indistinctness of the gene pool within or among the populations under study, and with populations of closely related taxa. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. These studies should be national in scope and address all

cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. (USFWS, 1986)

- Develop cultivated stocks for commercial distribution. Cultivated stocks can be developed by authorized, responsible and/or licensed agencies, e.g., botanical gardens, universities, etc., for sale to licensed commercial distributors if information from the trade study indicates this is a practical method of reducing collecting pressure. Such trade will be subject to applicable Federal or State permits and reporting requirements. (USFWS, 1986)
- Determine delisting criteria. Before the variety can be downlisted to threatened, at least two of the three known populations should be established as safe sites. Criteria for delisting will be established only after the success of management at permanently protected populations can be evaluated and a search for additional populations has been conducted. (USFWS, 1986)
- Develop public awareness, appreciation, and support for preservation of the black lace cactus. The full recovery of the black lace cactus, and of other endangered species, depends on the attitude and support of the public. Educational materials and presentations should be used to gain public appreciation of the endan- gered species, and support for the program to save it. (USFWS, 1986)
- Recommended Action from 2009 5-Year Review: Thorough, systematic searches for new BLC populations are needed throughout the species' range. Potential habitat should be identified and surveyed, once landowner permission has been granted. Although saline soils underlie all three BLC sites, more indepth soils investigation at the known populations may help to further characterize specific soils and geologic properties that would aid in identifying areas in which to concentrate future population searches. In light of taxonomic controversy regarding the E. reichenbachii-fitchii complex, a thorough systematic review, including genetic studies of the species complex, should be conducted. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: Collaborative studies should be done to investigate life history requirements, including reproductive biology, and propagation techniques. Experimental studies need to address current and potential threats including impacts of insecticide on cacti pollinators and native seed dispersers such as ants and direct threats to BLC from non-native red imported fire ants, as well as from native insects. Feral hog activity levels within BLC populations should be monitored to ascertain the level of damage that occurs from uprooting of, and potentially from foraging on, BLC caused by these animals. In addition, the role of fire in the management of the species should be examined. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: All known populations of BLC exist on private lands. The Service and TPWD should pursue development of conservation plans with current landowners, along with investigating potential for permanent conservation easements. The assessment of appropriate conservation/management measures should be collaborative between landowners, resource agencies, and researchers. Evaluation of the species' status, degree of threats, and level of protection at known population sites is needed on a more frequent and regular basis. Landowners should be informed of new management strategies. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: Public education should be implemented to educate others about this endangered species and to protect the species from becoming a target of illegal take and distribution. Information about the regulations governing take and propagation of wild and nursery species for trade should be distributed to appropriate

partners. Refugia specimens should be grown and maintained to further aid in propagation studies and to enhance the ability of nurseries, botanical gardens, and the general public to identify the species, if encountered. (USFWS, 2009)

- Recommended Action from 2009 5-Year Review: The recovery plan for the species needs to be revised to incorporate all new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria for down- and delisting of the species should be developed which also address all listing factors relevant to the species. (USFWS, 2009)

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# SPECIES ACCOUNT: *Enceliopsis nudicaulis var. corrugata* (Ash Meadows sunray)

***Species Taxonomic and Listing Information***

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

**Physical Description**

Enceliopsis nudicaulis var. corrugata is a perennial plant in Asteraceae (sunflower family) that forms clumps 3.9 to 15.7 inches (in) (10 to 40 centimeters (cm)) high that rise from a stout, woody root-stock (Mozingo and Williams 1980, p. 21). The varietal name corrugata refers to leaf margins that are strongly ruffled-corrugate, especially towards the margins (Cronquist 1972, p. 246; Mozingo and Williams 1980, p. 21). The ray flowers are yellow and number 11 to 23. (USFWS, 2011)

**Historical Range**

See current range/distribution.

**Current Range**

Enceliopsis nudicaulis var. corrugata is endemic to the Ash Meadows area of Nye County, Nevada. The range of E. nudicaulis var. corrugata encompasses the Ash Meadows National Wildlife Refuge (Refuge) and adjacent Bureau of Land Management's (BLM) Ash Meadows Area of Critical Environmental Concern (ACEC) and private lands. (USFWS, 2011)

**Critical Habitat Designated**

Yes; 5/20/1985.

**Legal Description**

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Enceliopsis nudicaulis var. corrugata (Ash Meadows sunray) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat units (CHU), in Nevada (50 FR 20777-20794).

**Critical Habitat Designation**

The critical habitat designation for Enceliopsis nudicaulis var. corrugata includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Enceliopsis nudicaulis var. corrugata critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include dry washes or whitish saline soil associated with outcrops of pale whitish limestone.

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: Enceliopsis nudicaulis var. corrugata flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). (USFWS, 2011)

**Breeding Season**

Adult: March to May (USFWS, 2011)

**Reproduction Narrative**

Adult: Inflorescence buds begin developing in February and flowers open from late March to late May (Mozingo and Williams 1980, p.21; Pavlik and Moore 2010, p. 51). Enceliopsis nudicaulis var. corrugata flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). In 2008, the average E. nudicaulis var. corrugata plant output was 12.7 inflorescences and 11.5 infructescences; while in 2009, plant output averaged 18.5 inflorescences and 15.5 infructescences (Pavlik and Moore 2010, p. 52). Inflorescences that developed earlier in the season produced significantly more seeds than those developing later (Pavlik and Moore 2010, p. 52). Plants approximately produced 17.4 mature seeds per bud (Pavlik and Moore 2010, p. 88, Table 16). (USFWS, 2011)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Alkali shrub-scrub, salt desert scrub, desert pavement, pale limestone outcrops, dry washes, spring and seep areas (USFWS, 2011)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations between 617 to 719 m (2,200 to 2,360 ft) (USFWS, 2011)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: Enceliopsis nudicaulis var. corrugata occurs between 2,200 and 2,360 feet (ft) (671 and 719 meters (m)) above mean sea level and occurs across a broad range of Refuge habitats including occasionally moist alkaline soils, spring and seep areas, and dry desert washes (Morefield 2001, p. 1; BIO-WEST 2011, p. 113). Enceliopsis nudicaulis var. corrugata most often occupies intermittently flooded to upland mesic Alkali Shrub-Scrub habitat in alkali-clay soil and is occasionally a component of Salt Desert Scrub and Desert Pavement (embedded, tightly packed gravel) habitats (BIO-WEST 2011, p. 113). (USFWS, 2011)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**
Not available

**Number of Populations:**
30 (USFWS, 2011)

**Population Size:**
79,508 (USFWS, 2011)

**Adaptability:**
Low (inferred from USFWS, 2011)

**Population Narrative:**
Results from the 2008-2010 Refuge wide survey (BIO-WEST 2011, p. 114) estimate that 79,508 individuals are present on the Refuge in 30 minimum scale occurrences (0.1 mi (0.16 km) distance) or 1 maximum scale occurrence (0.6 mi (1 km) distance). (USFWS, 2011)

***Threats and Stressors***

**Stressor:** Groundwater withdrawal (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Refuge encompasses over 23,000 ac (9,172 ha) of spring-fed wetlands and alkaline, desert uplands. More than 50 seeps and springs occur on the Refuge. At the time of listing, groundwater withdrawal was a major threat to the entire Ash Meadows ecosystem. Local groundwater pumping at Ash Meadows (prior to the establishment of the Refuge) was responsible for the destruction of many populations of plants and animals and their wetland habitats. Enceliopsis nudicaulis var. corrugata depends on near-surface water for its survival; therefore, it is reasonable to conclude that additional declines in groundwater levels in the Ash Meadows area (e.g., due to groundwater pumping) would negatively affect populations of this species. A number of measures have been implemented since the 1970’s that, in part, have reduced the risk of groundwater level declines at the Refuge. The significance of the remaining threat posed by groundwater pumping will be evaluated below with respect to each of these measures. (USFWS, 2011)

**Stressor:** Road construction (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, Enceliopsis nudicaulis var. corrugata population numbers had been reduced by the loss of habitat from road construction. Since listing, the Service has ceased road construction and maintains only defined Refuge roads that allow for administrative, visitor, and private landowner access. Truckers often use Refuge roads to avoid the need to obtain permits required to transport loads through California (Service and DOT 2011, p. 27). A

transportation study is being completed by the Refuge to identify transportation improvements and management strategies, improve safety, reduce operations and maintenance costs, ensure accessibility, and address traffic circulation needs (Service and Department of Transportation (DOT) 2011, pp. 1-98). Due to ceased road construction and initiation of a transportation study, road construction is no longer a threat to Enceliopsis nudicaulis var. corrugata. (USFWS, 2011)

**Stressor:** Off-highway vehicle (OHV) activity (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Prior to listing, OHV activity was a threat to Enceliopsis nudicaulis var. corrugata. OHV races were permitted on BLM land in the Ash Meadows area. Since listing, OHV activity is prohibited on the Refuge and has been limited by the construction of fencing around the perimeter of the Refuge in 1995 (Service 2006, pp. 9, 103). Periodically, illegal OHV activity, likely due to downed sections of fencing and fence cutting, occurs on the Refuge (Baldino, pers. comm. 2010). Within the BLM ACEC, OHV activity is confined to existing roads, trails, and dry washes (BLM 1998a, Chapter 2 p. 2-32; Map 2-10). Signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, making it unclear to the public that the BLM land surrounding the Refuge has a special ACEC designation (Baldino, pers. comm. 2010). Due to the periodic illegal OHV activity on the Refuge and undefined ACEC designation, OHV activity is still a threat to Enceliopsis nudicaulis var. corrugata. (USFWS, 2011)

**Stressor:** Trampling by resident wild and free-roaming horses (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The final listing rule described trampling by wild and free-roaming horses as a threat to Enceliopsis nudicaulis var. corrugata. Since then, in 1995, a fence was constructed around the perimeter of the Refuge (Service 2006, pp. 9, 103). As a result, wild horse activity on the Refuge was stopped. In 1998, the BLM established the Ash Meadows ACEC that surrounds the Refuge and established the appropriate management level (AML) for wild horses as zero (BLM 1998b, p. 7 Table 2-5). Fences are not present to keep horses out of the designated ACEC and they have been seen infrequently near the area (Baldino, pers. comm., 2011). Thus, inspection and maintenance of the exclusionary fence on the Refuge is necessary to prevent re-invasion (Service 2006, p. 99). Due to these positive management practices, trampling by wild and freeroaming horses is no longer a threat to E. nudicaulis var. corrugata on the Refuge, but occasionally may be a threat to E. nudicaulis var. corrugata within the BLM ACEC. (USFWS, 2011)

**Stressor:** Non-native plant species (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, non-native plants species have been identified as a threat to Enceliopsis nudicaulis var. corrugata. An estimated 42 percent of all species listed under the Act are considered to be at risk primarily due to non-native species (Pimental et al. 2005, p.1). Non-native plants directly compete with native plants for water, nutrients, and sunlight and indirectly by altering ecosystem processes such as hydrology, productivity, nutrient cycling, and fire regime (D’Antonio and Vitousek 1992, pp.63-87; Levine et al. 2003, pp. 775-781; Brooks et al. 2004,

pp.677-688). Approximately 100 non-native species occur on the Refuge; 66 of them non-native plant species (Service, 2006, p. 7, pp. 52-53). Of these Tamarix ramosissima Ledeb. (saltcedar), Acroptilon repens (L.) DC. (Russian knapweed), Bassia hyssopifolia (Pall.) Kuntz (fivehorn smotherweed), Centaurea melitensis L. (Malta starthistle), and Bromus rubens L. (red brome) could potentially threaten E. nudicaulis var. corrugata. (USFWS, 2011)

**Stressor:** Wildfire (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, nine wildfires have burned on the Refuge (Sunderman and Weisburg 2011, p. 3). The three largest wildfires (Fairbank fire in 2000 which was 744 ac (301 ha); Longstreet fire in 2004 which was 1,401 ac (567 ha); and Meadows fire in 2005 which was 267 ac (108 ha) were all partially in Enceliopsis nudicaulis var. corrugata habitat and burned prior to initiation of weed treatments in non-native plant species patches of Tamarix ramosissima. Non-native plant species alter ecosystem dynamics such as fire regimes. For example, on the Refuge, Bromus rubens is an annual, nonnative grass, that could increase its dominance on the landscape under climate change predictions. In turn, this would increase the density of fine fuels and create an environment more susceptible to fire (Chambers and Pellant 2008, p. 31). With the exhaustion of SNPLMA funding for non-native plant species treatments and opportunity for them to re-invade, wildfire frequency may increase through alteration of the fire regime. In addition, non-native plant species such as Bromus rubens could invade sparsely vegetated Enceliopsis nudicaulis var. corrugata habitat, thus providing a vector to carry fire into a habitat that may have less tendency to burn. The threat of wildfire is not easily accessed and is dependent on many other factors, thus we conclude that it is a potential threat to E. nudicaulis var. corrugata. (USFWS, 2011)

**Stressor:** Surface mining (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Refuge is located in the Ash Meadows mining district (Tingley 1998, p. 20), which has the largest clay production of any district in Nevada (BLM 1998a, p. 3-75). At the time of listing, surface mining was identified as a threat to two other listed plant species, Grindelia fraxinopratensis and Astragalus phoenix. Surface mining also poses a threat to Enceliopsis nudicaulis var. corrugata which co-occurs in many places with A. phoenix. Currently, only mining for clay minerals occurs in the Ash Meadows area. The playa sediments covering much of the Refuge contain clays and other minerals that could be classified as locatable minerals under the Mining Law of 1872, as amended (BLM and Service 2000, p. 3-1). Under the Mining Act of 1872, surface disturbance and impacts to rare species that do not have Federal protection are permissible as long as operations comply with all pertinent Federal and State laws. New mineral claims and mining could cause direct loss of E. nudicaulis var. corrugata habitat as well as indirect impacts due to diverting or draining water from occupied habitat. (USFWS, 2011)

**Stressor:** Solar development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Since listing, solar development has been identified as a threat to Enceliopsis nudicaulis var. corrugata, specifically due to impacts from groundwater withdrawal. The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) to be evaluated for its environmental and resource sustainability for larger-scale solar energy production (Department of Interior (DOI), 2009, p. 1). The Refuge is located about 20 mi (32 km) southeast of the SEZ (DOE/EIS 2010, pp. 11.1-21). The SEZ is a proposed area of 31,625 acres (12,798 ha) and maximum solar development of this area is assumed to be 80 percent over a period of 20 years on 25,300 ac (10,239 ha) (DOE/EIS 2010, pp. 11.1-1 to 11.1-3). In November 2010, the BLM approved the construction of the first solar project in the SEZ: Solar Millennium, LCC on Amargosa Farm Road. This project is on 6,320 ac (2,558 ha) of land and will use dry-cooled technology. Total annual operational water usage is 400 ac-ft (493,393 m3) per year, but will require 600 ac-ft (740,089 m3) a year during construction (BLM 2010b, p.4; Service 2010a, p. 4). Application 79699 is an application for a change in the manner of use and place of use of 400 afy under existing Permit 15893 (Certificate 5717). Changing the use of 400 ac-ft (493,393 m3) per year of water from irrigation to industrial use for this solar project and the solar projects that will follow is likely to have an impact on the groundwater supply. Agricultural water use allows some water to percolate back into the groundwater system (return flow). Water used for industrial utility-scale solar energy production likely will evaporate and not recharge to the aquifer. Additionally, no significant return flow is anticipated from solar mirror washing operations or other water uses given the average low humidity and high temperatures in the Mojave Desert. Small declines in spring discharge, changes in water temperature, and adjustments in soil or water chemistry resulting from solar projects groundwater withdrawals in the basin would negatively affect Enceliopsis nudicaulis var. corrugata. (USFWS, 2011)

**Stressor:** Predation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pavlik and Moore (2010, pp. 38, 52) noted that both jackrabbit (Lepus californicus) and insect herbivory had a dramatic effect on E. nudicaulis var. corrugata. 6.7 percent of marked E. nudicaulis var. corrugata plants in 2008 and 51.7 percent of marked E. nudicaulis var. corrugata plants in 2009 had inflorescences removed by jackrabbits, as evidenced by droppings around affected plants (Pavlik and Moore 2010, p. 52). In addition, insect achene predators severely damaged 91.7 percent of infructescences in 2008 and 78.3 percent of infructescences in 2009 (Pavlik and Moore 2010, p. 52). (USFWS. 2011)

**Stressor:** Stochastic events (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small, endemic populations with limited geographic distribution like Enceliopsis nudicaulis var. corrugata have a higher risk of extinction due to demographic and environmental uncertainty and natural catastrophes (Shaffer 1987, pp. 69-75; Lande 1993, pp. 911-927). Enceliopsis nudicaulis var. corrugata is known only from the Ash Meadows area. All mapped occurrences of E. nudicaulis var. corrugata are restricted to the Refuge. Drought and wildfire are the most likely stochastic events that could adversely affect E. nudicaulis var. corrugata, as this species is dependent on groundwater and moisture retained in the soil and susceptible to being destroyed by a single, large fire. We conclude that stochastic events are a threat to E. nudicaulis

var. corrugata. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Enceliopsis nudicaulis var. corrugata is dependent on the springs and seeps of the Refuge. The potential effects of climate change on the regional aquifer system that supports E.nudicaulis var. corrugata are unclear. Current climatic models are predicting warmer air temperatures due to elevated levels of atmospheric carbon dioxide and increased drought and flood frequency (Intergovernmental Panel on Climate Change (IPCC) 2007, pp. 2-3). Other effects of climate change include, but are not limited to, changes in types of precipitation (Knowles et al. 2006, p. 4557), earlier spring run-off (Stewart et al. 2005, p. 1152), longer and more intense fire seasons (Chambers and Pellant 2008, pp. 31-32), increases in exotic species invasions (Hawkins et al. 2008, p. 37; Bradley et al. 2010, pp. 310-318), and more frequent extreme weather events (IPCC 2007, p. 13). The springs and surface streams that support Enceliopsis nudicaulis var. corrugata are perennial and originate from a regional aquifer that includes runoff from the Spring Mountains approximately 100 mi (161 km) northeast (USGS 2003, pp. 7-9). As a result of warming, more winter precipitation is falling as rain, and has altered spring stream flow. Snowmelt driven stream flow in spring is about 10 to 15 days earlier than 50 years ago, which increases the frequency of drought by decreasing groundwater recharge and summer water reserves (IPCC 2007; Chambers and Pellant 2008, p. 30). Increasing temperatures and drought frequency could adversely affect Enceliopsis nudicaulis var. corrugata by causing physiological stress, altering phenology, reducing recruitment events and seedling establishment, and altering fire frequencies. At this time, it is difficult to predict local climate change impacts to E. nudicaulis var. corrugata; thus, while the information indicates that climate change has the potential to affect and threaten its ecosystem in the long-term, there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change. (USFWS, 2011)

***Recovery***

**Reclassification Criteria:**
1. All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive. (USFWS, 2011)

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devil’s Hole is maintained at a minimum level of 1.4 feet below the copper washer. (USFWS, 2011)

3. The essential habitat must be secure from detrimental human disturbances including mining, OHVs, and introduction of non-native species. (USFWS, 2011)

Recovery Priority Number: 9

**Delisting Criteria:**
1. Criteria shown above for downlisting from endangered to threatened. (USFWS, 2011)

2. Secure, protect, and maintain in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of listed plants within the essential habitat. (USFWS, 2011)

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats. (USFWS, 2011)

4. All of the listed plant species and the four candidate plants species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population. (USFWS, 2011)

**Recovery Actions:**
- Secure habitat and water sources for the Ash Meadows ecosystem. (USFWS, 1990)
- Conduct research on the biology of the species. (USFWS, 1990)
- Conduct management activities within essential habitat. (USFWS, 1990)
- Reestablish populations/monitor new & existing populations. (USFWS, 1990)
- Determine/verify recovery objectives. (USFWS, 1990)
- The Recovery Plan should be updated using the most recent and best scientific management information available. (USFWS, 2011)
- Surveys for Ash Meadows threatened and endangered plant species, including Enceliopsis nudicaulis var. corrugata, should be performed in the BLM ACEC to determine species occurrences and habitat locations. In addition, habitat surveys around roads, trails, and dry washes will verify the impact OHV activity has on this species population. (USFWS, 2011)
- Research on the life history strategies of Enceliopsis nudicaulis var. corrugata should be prioritized. Research should focus on demography, recruitment events, and seed longevity in the seed bank. (USFWS, 2011)
- Seed from all listed plant species, including Enceliopsis nudicaulis var. corrugata, on the Refuge should be collected and stored for ex situ conservation. Ex situ studies of seed and seedling biology should be conducted to enhance germination and propagation techniques. (USFWS, 2011)
- Additional research is needed on the sensitivity and requirements of the species on groundwater and soil moisture throughout the growing season. (USFWS, 2011)
- The Refuge is implementing many restoration projects that could benefit Enceliopsis nudicaulis var. corrugata; however minimal monitoring specific to listed plants is conducted. To document recovery of listed plants, these projects should include pre and post site sampling to verify and quantify the restoration actions as benefiting the species. (USFWS, 2011)
- Environmental analyses on new solar projects in Amargosa Valley should include detailed assessments of the potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these documents to ensure that they adequately disclose all potential impacts to Enceliopsis nudicaulis var. corrugata and the Ash Meadows ecosystem. (USFWS, 2011)
- Long-term funding should be secured for long-term non-native plant species treatments on the Refuge. (USFWS, 2011)

- Mineral rights should be purchased or transferred for perpetuity to the Service or a program needs to be established to renew the mineral withdrawal every 20 years. In addition, existing mining claims should be acquired whenever possible. (USFWS, 2011)
- Property and rights, such as conservation easements, should be acquired on private property that likely contains listed plant species. (USFWS, 2011)
- Research and develop a jackrabbit exclusion study to determine the impacts jackrabbits are having on reproduction of Enceliopsis nudicaulis var. corrugata. If a significant affect to E. nudicaulis var. corrugata is found, a jackrabbit control plan should be established. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: (optional, but may be helpful to identify priorities for management actions and information needs for next 5-year review) 1. Monitor compliance with the January 12, 2018 Nevada Revised Statute Order 1197A, Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, to ensure groundwater levels in Devils Hole can support the population. Order 1197 is no longer in effect. Water levels in Devils Hole are affected by pumping centers in Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020); 2. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service, 2020); 3. Support Ash Meadows sunray (Enceliopsis nudicaulis var. corrugata) research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and 4. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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# SPECIES ACCOUNT: *Eremalche kernensis* (Kern mallow)

***Species Taxonomic and Listing Information***

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

**Physical Description**

Annual herb, with erect stem about two to four inches high; white to rose-pink or lavender hollyhock-like flowers (Fish and Wildlife Service 1990). (NatureServe, 2015)

**Taxonomy**

Treated as Eremalche kernensis by some, including the USFWS. The distinctiveness of this taxon is in question (Roxanne Bittman, California Natural Diversity Database, June 2000). (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

California endemic, occurring only in Kern County (Skinner 1997). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Grasslands (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits chenopod scrub, valley and foothill grassland; 70-1000 m (Skinner 1997). (NatureServe, 2015)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

6 - 20 (NatureServe, 2015)

**Population Narrative:**

Known from fewer than twenty occurrences (Skinner 1997). (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is a potential threat to E. kernensis. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2013).

**Stressor:** Effects of nitrogen deposition (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nitrogen is considered a limiting factor in the soils of many terrestrial ecosystems. Nitrogen deposition "hotspots" have been identified downwind of large and expanding metropolitan centers and large agricultural operations in California. Increased soil nitrogen from anthropogenic sources such as automobile exhaust, can lead to increased plant productivity in Nlimited soils. In areas where non-native nitrophilic (i.e., nitrogen-loving) plants have been introduced (such as Bromus madritensis ssp. rubens or red brome), this increased productivity can result in competitive exclusion, whereby the faster growing nitrophilic species out-compete the native vegetation. Smaller-statured forbs (like E. kernensis) can be particularly vulnerable. The increased productivity of non-native annual grasses can also lead to increased fire frequency due to the build-up of fuel. The habitats in which Eremalche kernensis occurs are not fire-adapted, and the native vegetation does not recover quickly after burning (USFWS, 2013).

**Stressor:** Grazing and competition (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Grazing and competition from non-native plant species are threats to the species, although grazing, when done appropriately, may be an important tool in eliminating competition from both non-native and native competitors of Eremalche kernensis(USFWS, 2013).

**Stressor:** Habitat destruction and modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats to habitat of Eremalche kernensis include conversion to agriculture (including grazing) and urbanization (on privately owned lands); the occurrences on public lands are protected from direct effects of urbanization and agricultural land conversion, but in some areas are still subject to other threats including oil and gas exploration and conveyance, solar power developments, off-road vehicle use and mineral exploration and extraction (USFWS, 2013).

**Stressor:** Potential loss of pollinators (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** While it is unknown whether honeybees specifically function as pollinators of E. kernensis, if the causes of colony collapse disorder result in a decline in any E. kernensis pollinators, the species' genetic diversity could be further reduced (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
1. Secure and protect specified recovery areas from incompatible uses: a. 95% of occupied habitat on public lands; b. 75% of population and 75% of occupied habitat in Lokern. 2. Management Plan approved and implemented for recovery areas in the Lokern Area that include survival of the species as an objective. 3. Population monitoring in specified recovery areas shows stable or increasing populations through a precipitation cycle. (USFWS, 2020)

**Delisting Criteria:**
1. Secure and protect specified recovery areas from incompatible uses: a. 90% or more each of population and occupied habitat in Lokern; b. Two or more distinct populations outside the Lokern Natural Area. 2. Management Plan approved and implemented for all protected areas that include survival of the species as an objective. 3. Population monitoring in specified recovery areas shows no decline after downlisting. If declining, determine cause and reverse trend. (USFWS, 2020)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2013 five-year review, scientific literature, and as a result of discussions with species experts. 1. Conduct more robust genetic testing to determine the distinction between Kern mallow (Eremalche parryi ssp. kernensis) and the closely-related Parry's mallow (Eremalche parryi ssp. parryi). 2. A comprehensive evaluation should be completed for all known occurrences (both extant and extirpated). The site-specific evaluation should include, at minimum, whether the species is present, estimated population/occurrence extent, extent of suitable habitat, and an in-depth analysis of threats at that location. Field surveys for the evaluation should be timed for favorable conditions, such as in the first wet year following a drought. 3. Conduct yearly surveys utilizing a standardized methodology to determine trends in the range-wide status of the species as well as population/occurrence abundance. 4. Monitor known populations of Kern mallow during multiple precipitation/drought cycles to gain a better understanding of the ecology of the species and how it interacts with grazing and with other species (both native and non-native). (USFWS, 2020)

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USFWS. 2020. 5-YEAR REVIEW Kern mallow (Eremalche kernensis = Eremalche parryi ssp. kernensis). 7 pp.

# SPECIES ACCOUNT: *Eriastrum densifolium ssp. sanctorum* (Santa Ana River woolly-star)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/28/1987; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

Eriastrum densifolium subsp. Sanctorum is a subshrub occasionally reaching 1 m (3.3 ft) in height. Plants have gray-green stems and leaves. The light gray-green leaves generally curve upward. The leaves are irregularly divided to the midrib in 2 to 6 narrow lobes and are up to 50 mm (2 in) long (Patterson 1993, p. 826). The bright blue funnel-shaped flowers are usually longer than 25 mm (1.0 in), but may be up to 30 mm (1.4 in) long or occasionally as short as 20 mm (0.8 in). The petals of the flowers (corolla) are lavender-blue becoming pinkish-purple with age (Munoz 1991). The congested inflorescences (flower stalks) contain 20 flowers each. The seeds are contained in capsules. (USFWS, 2010)

**Taxonomy**

Four other subspecies of Eriastrum densifolium have been recognized. A key feature that distinguishes E. d. subsp. Sanctorum from other subspecies is the length of the tube forming the base of the corolla that is up to 30 mm (1.2 in); corolla tube lengths in the other subspecies do not exceed 20 mm (0.8 in) (Patterson, 1993). (USFWS, 2010)

**Historical Range**

Historically, E. d. subsp. sanctorum occupied about 110 km (60 mi) of habitat along the Santa Ana River from elevations of about 150 m (500 ft) in the vicinity of Santa Ana Canyon in Orange County up to about 600 m (2,000 ft) at the base of the San Bernardino Mountains, through Riverside County (USFWS 1987, p. 36266). Eriastrum densifolium subsp. sanctorum may have occupied alluvial fan sage scrub habitats in Orange County as far downstream as Santiago Canyon (Craig 1934, p. 390; Mason 1945, p. 75; Zembal and Kramer 1984, p. 2). The subspecies is considered extirpated from Orange County and Riverside County (Zembal and Kramer 1985, p. 3; USFWS 1987, p. 36268). At listing, Eriastrum densifolium subsp. sanctorum occurred in isolated stands along the Santa Ana River in San Bernardino County between 360 and 600 m (1,200 and 2,000 ft) in elevation. (USFWS, 2010)

**Current Range**

Eriastrum densifolium subsp. sanctorum is endemic to the Santa Ana River drainage of southern California. Since listing, 12 new occurrences were detected, and Eriastrum densifolium subsp. sanctorum was also rediscovered within Riverside County just downstream of the border with San Bernardino County. (USFWS, 2010)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (self-incompatible) (USFWS, 2010)

**Lifespan**

Adult: 5 to 10 years (USFWS, 2010)

**Dependency on Other Individuals or Species**

Adult: Many species of insects and birds visit Eriastrum densifolium subsp. sanctorum flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (Micranthophora flavocincta), giant flower-loving fly (Rhaphiomidas acton subsp. acton), California bumblebee (Bombus californicus), white-lined sphinx moth (Hyles lineata), black-chinned hummingbird (Arhilochus alexandri), and Anna's hummingbird (Calypte anna) (Muñoz 1991, p. 59). (USFWS, 2010)

**Breeding Season**

Adult: May to August (USFWS, 2010)

**Reproduction Narrative**

Adult: Eriastrum densifolium subsp. sanctorum flowers between May and August but most heavily in June (Muñoz 1991, p. 22). In artificial crossing experiments, self-pollination produced negligible fruit or seed set, indicating that E. d. subsp. sanctorum is self-incompatible (Muñoz 1991, p. 9; Brunell 1999, p. 250). Many species of insects and birds visit Eriastrum densifolium subsp. sanctorum flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (Micranthophora flavocincta), giant flower-loving fly (Rhaphiomidas acton subsp. acton), California bumblebee (Bombus californicus), white-lined sphinx moth (Hyles lineata), black-chinned hummingbird (Arhilochus alexandri), and Anna's hummingbird (Calypte anna) (Muñoz 1991, p. 59). Eriastrum densifolium subsp. sanctorum plants have an average life span of approximately 5 years with some plants surviving at least 10 years (Burk et al. 1998, p. 21). (USFWS, 2010)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Chaparral, coastal scrub (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Flooding provides habitat and seed dispersal (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: Prefers low annual cover, well-lighted areas with slight surface disturbance; found at elevations below 600 m (2,000 ft) (USFWS, 2010)

**Spatial Arrangements of the Population**

Adult: Patchy (USFWS, 2010)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Eriastrum densifolium subsp. Sanctorum thrives in open, well-lighted areas of sand alluvial terraces, where shrublands persist between infrequent flood events (Zembal and Kramer 1984, p. 8; Wheeler 1988, p. 3; Burk et al. 1998, p. 20). The perennial vegetative cover is relative low (seldcom over 50%); annual cover is also fairly low (Zembal and Kramer 1984, p. 4). This species is found in disjunct stands within this habitat and tends to occupy areas with slight disturbance (Zembal and Kramer 1984, p. 4). Eriastrum densifolium subsp. sanctorum is known to occur patchily on the higher floodplain terraces. E. d. ssp. sanctorum colonizes washed sand deposits created by sporadic stream flow action and its habitat is maintained by periodic flooding, scouring, and sediment deposition (Wheeler 1998, p. 16). It thrives in nutrient poor sands of early seral stage habitat that have more than 97% sand particles. Eriastrum densifolium subsp. austromontanum occurs at elevations from 1,200 to 1,800 m (4,000 to 8,000 ft). Most commonly associated perennial plants include Eriogonum fasciculatum, Eriodictyon trichocalyx, Croton californicus, and Lepidospartum squamatum (Zembal and Kramer 1985). (USFWS, 2010)

***Dispersal/Migration***

**Dispersal**

Adult: Typically low, but may be high during flooding events (USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: Dispersal of Eriastrum densifolium subsp. sanctorum seed is limited in the absence of flooding. The majority of seeds fall within 0.3 m (1 ft) of the parent plant and the wetted seed coat forms a mucilaginous mass that readily attaches the seed to the surrounding soil particles (Burk et al. 1989, p. 21). Those seeds not immediately shed from the fruits are retained within capsules that may remain on the plant for several seasons (Wheeler 1991, p. 116). In times of flooding, seeds or capsules may be transported down the floodplain for some distance, thereby facilitating some gene flow between populations. (USFWS, 2010)

***Population Information and Trends***

**Population Trends:**

Long-term trends indicate a rapid decline of 70 to 90%, while short-term trends suggest a decline of 50 to 70% (NatureServe, 2015)

**Number of Populations:**

23 occurrences (USFWS, 2010)

**Population Narrative:**

There are currently 23 extant or presumed extant occurrences of Eriastrum densifolium subsp. sanctorum, 2 more than documented in the 2010 5-Year Review (Figure 1; Appendix A). Several occurrences are in need of monitoring as there are no survey records for decades, making it hard to accurately determine the occupancy at these occurrences. (USFWS, 2023)

***Threats and Stressors***

**Stressor:** Floodplain development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At listing, urban and agricultural development was identified as a threat impacting habitat occupied by Eriastrum densifolium subsp. sanctorum (USFWS 1987, p. 36269). Prior to listing, the Devore occurrence (EO 15) was extirpated by agricultural development and discing (CNDDB 2010a, p. 9). Since listing, additional mainstem and tributary occurrences across the species distribution in San Bernardino, Riverside, and Orange Counties have been directly impacted or extirpated by development related activities: Verdemont (EO 18) in Cajon Creek Wash may have been eliminated when disced in 2005; Highland Avenue (EO 3) in Lytle Creek Wash was extirpated by construction of California Freeway 210 (Foothill Freeway); Jensen Quarry (EO 27) in Sunnyslope was extirpated by construction of the Oak Quarry Golf Club; and the sole Orange County occurrence, Weir Canyon Road (EO 2), may have been extirpated by construction of a nearby subdivision (CNDDB 2010a, p. 220). Adverse effects from development continue to be a threat to E. d. subsp. sanctorum occurrences, and impacts from current and planned development projects in the Santa Ana River floodplain habitat. These developments within the floodplain impact the species by displacing it from limited suitable habitat. Floodplain development projects also affecting the hydrological regime. (USFWS, 2010)

**Stressor:** Aggregate mining (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At listing, aggregate mining was identified as a threat impacting habitat occupied by Eriastrum densifolium subsp. sanctorum (USFWS 1987, p. 36268). Aggregate mining activities directly eliminate habitat and can degrade or fragment suitable habitat. Mining operations were quite active at the time of listing and impacted over 1,500 acres (ac) (600 hectares (ha)) of the Santa Ana River wash according to accounts shortly after listing (USFWS 1998, p. 3837). Since listing, threats associated with aggregate mining remain a threat at many mainstem and tributary occurrences. There are mining activities indicated as threats near 4 of the 21 occurrences: Institution Road North (EO 33), Institution Road South (EO 4), and Line Avenue (EO 20) in Cajon Creek Wash, and Santa Ana Wash (EO 5) on the Santa Ana River mainstem (CNDDB 2010). Though no new aggregate mining is currently planned for the Santa Ana River mainstem, the level of impact to Eriastrum densifolium subsp. sanctorum associated with ongoing aggregate mining is unknown. (USFWS, 2010)

**Stressor:** Alteration of hydrology (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At listing, it was predicted that Seven Oaks Dam would greatly reduce peak flow volumes and sediment loads that would drastically reduce the frequency of scouring and depositional events in the floodplain and allow most of the alluvial fan sage scrub communities on the Santa Ana River Wash to succeed to a uniform mature phase, reducing the seedling establishment of Eriastrum densifolium subsp. sanctorum in downstream habitats (USFWS 2008, p. 3). Absence of these scouring and depositional events could preclude all but the mature seral stages in the alluvial fan sage scrub. Since listing, this subspecies continues to be threatened

rangewide by floodplain modifications that alter hydrology, which directly and indirectly eliminate or impair habitat function. The habitat of the Santa Ana River and its tributaries receives little natural disturbance. Sheet flood flows probably occur once every 100 to 200 years and the scouring of such flows appear to maintain the alluvial fan scrub vegetation (USFWS 1986, p. 12181). Flood events are now confined to trenches and channels in Lytle Creek and the Santa Ana River, replacing the alluvial floodplain and the associated alluvial terraces. Constructed flood control channels prevent water from flowing out onto adjacent banks, providing the scouring and redeposition needed by Eriastrum densifolium subsp. sanctorum. The deeper water in these channels serves to increase the flow velocity and increases channel incision with less alluvial deposition. Flood control channels serve to promote mature successional stages of alluvial fan sage scrub, which provides poor establishment potential for E. d. subsp. sanctorum (Wheeler 1991, p. 56). Six occurrences are affected by grading for flood control: Line Avenue (EO 20), Santa Ana Wash (EO 5), Riverside Avenue (EO 21), Alamo Street (EO 22), Fairmont Park Golf Course (EO 24), and Weir Canyon Road (EO 2). Additionally, the construction of Seven Oaks Dam has removed much of the fluvial dynamics from the mainstem of the Santa Ana River and precludes natural scouring and deposition in the future. As discussed in the Habitat section above, the inhibition of flooding events allows for the seral maturation of the alluvial fan sage scrub. This mature scrub then inhibits the establishment of E. d. subsp. sanctorum seedlings, which could ultimately lead to local extirpations. All 14 occurrences on the Santa Ana River are adversely impacted by altered hydrology resulting from the Seven Oaks Dam. In all, 15 of the 21 extant occurrences are threatened by alterations of hydrology. (USFWS, 2010)

**Stressor:** Off-highway vehicles (OHVs) (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** OHV use directly damages plant communities and the soil horizon of Eriastrum densifolium subsp. sanctorum occurrences, thereby degrading habitat. Large flat expanses of alluvial fan sage scrub habitat that support E. d. subsp. sanctorum are also attractive to recreationists for OHV use. Impacts from OHV use is known to occur throughout the species' range and specifically at 11 of the 21 occurrences in Cajon Creek Wash (EOs 33, 4), Lytle Creek Wash (EO 19), and the Santa Ana River mainstem (EOs 5, 1, 25, 29, 21, 22, 24, and 31) (CNDDB 2010). Unauthorized OHV use continues to degrade alluvial fan sage scrub habitat areas within Cajon Creek Wash, Lytle Creek Wash, and the mainstem of the Santa Ana River. Control of these activities rests with local landowners and jurisdictions. Three occurrences are conserved and afforded protection under the Western Riverside County Multiple Species Habitat Conservation Plan (Western Riverside County MSHCP) (EOs 22, 24, and 31). We anticipate that some impacts from OHVs will be ameliorated through active management with future implementation of the Woolly-Star Preserve Area Multiple Species Habitat Management Plan (WSPA). (USFWS, 2010)

**Stressor:** Hybridization (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hybridization was not discussed in the listing rule as a threat to Eriastrum densifolium subsp. sanctorum. Though hybridization, or the occurrence morphological intermediates (with E. d. subsp. elongatum or E. d. subsp. austromontanum) had been suspected since the 1930s, genetic verification did not occur until the occurrences in Lytle Creek were compared to those in

the Santa Ana River utilizing enzyme electrophoresis (Brunell and Rieseberg 1993). Similarly, hybridization was thought to occur with E. d. subsp. elongatum near the confluence of Lytle Creek and Cajon Creek (Verdemont (EO 18), Institution Road North (EO 33), and Institution Road South (EO 4)) (Craig 1934, p. 390; Burk et al. 1989, p. 20). The upper reaches of those washes seem to support E. d. subsp. elongatum while the listed entity is found downstream toward the Santa Ana River. Eriastrum densifolium subsp. austromontanum has also been thought to hybridize with E. d. subsp. sanctorum at La Cadeña Dr. and Lytle Creek (La Cadeña Drive (EO 29) and La Loma Hills (EO 30)) (DeGroot 2008, p. 1; Brunell and Whitkus 1997, p. 545). Though gene flow between E. d. subsp. sanctorum populations in the Santa Ana River and intermediates of Lytle Creek Wash likely took place in the recent past (150 years), they now appear isolated (Brunell and Rieseberg 1993, p. 5). The extent of threat from hybridization remains unknown. Hybrids have been confined to lower Lytle Creek Wash and the Santa Ana River at its confluence with Lytle Creek. Hybridization is a potential threat at 7 of the 21 occurrences. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Global climate change was not addressed as a threat in the final listing rule for the Eriastrum densifolium subsp. sanctorum. Since listing, it has become apparent that potential threats exist to biota of the United States from ongoing, accelerated climate change (IPCC 2007). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying are predicted for the foreseeable future (Field et al. 1999, pp. 1–63; Cayan et al. 2005, pp. 1–47; IPCC 2007). Significant temperature increases create a stressor for endemic species. This stressor enhances pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must somehow adapt to these pressures in situ (in place) or shift their geographic range (Cayan et al. 2009, p. 45). Such a shift in range for narrow endemic species such as Eriastrum densifolium subsp. sanctorum could exceed the tolerance of the subspecies. Additionally, there is very little available alluvial fan sage scrub habitat in the Santa Ana River basin to assist this subspecies with a range shift. Though we know little of the adaptive ability of E. d. subsp. sanctorum, climate change could potentially pose a significant rangewide threat to the subspecies. (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 6C

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Recovery actions are not available.
- Work with partners, such as the Service's Partners for Fish and Wildlife Program to identify opportunities for conservation or preservation for Eriastrum densifolium subsp. sanctorum

occurrences on private lands. Property easements or purchases of parcels could also be made through the Act's section 6 funding and other programs. (USFWS, 2010)

- Ensure natural recruitment of Eriastrum densifolium subsp. sanctorum is sufficiently documented following extreme fluvial events (i.e., floods) to assure long-term sustainability. (USFWS, 2010)
- Determine occurrences where genetic distinctness exists between occurrences in Cajon Creek, Lytle Creek, and the Santa Ana River mainstem that comprise the range of known hybrid of Eriastrum densifolium subsp. sanctorum. (USFWS, 2010)
- Develop a final recovery outline for Eriastrum densifolium subsp. sanctorum. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years. The actions are intended to reduce threats to Eriastrum densifolium subsp. sanctorum and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this subspecies will require cooperation and coordination with partners to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. 1. Work with partners to identify opportunities for conservation or preservation of E. d. subsp. sanctorum occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire suitable habitat. 2. Conduct rangewide surveys for E. d. subsp. sanctorum to help update the distribution and current baseline conditions. 3. Identify seed accessions within the California Botanical Garden (formerly Rancho Santa Ana Botanical Garden) seed bank and complete seed collection and viability testing. 4. Conduct small-scale E. d. subsp. sanctorum plant seeding experiments. 5. Determine extent of genetic differences between E. d. subsp. sanctorum populations. 6. Conduct experiments to determine how to restore Riversidean Alluvial Fan Sage Scrub habitat to help facilitate recolonization of E. d. subsp. sanctorum to alluvial benches (USFWS, 2023).

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# SPECIES ACCOUNT: *Erigeron decumbens* (Willamette daisy)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/24/2000; Pacific Region (R1)

**Physical Description**

The Willamette daisy is a taprooted perennial herb. It grows 1.5 to 6 cm (0.6 to 2.4 inches) tall, with erect to sometimes prostrate stems at the base. The basal leaves often wither prior to flowering and are mostly linear, 5 to 12 cm (2 to 5 inches) long and 3 to 4 mm (0.1 to 0.2 inches) wide. Flowering stems produce two to five heads, each of which is daisy-like, with pinkish to pale blue ray flowers and yellow disk flowers. The morphologically similar Eaton's fleabane (E. eatonii) occurs east of the Cascade Mountains, while the sympatric species Hall's aster (Aster hallii) flowers later in the summer. In its vegetative state, the Willamette daisy can be confused with Hall's aster, but close examination reveals the reddish stems of Hall's aster in contrast to the green stems of the Willamette daisy (Clark et al.1993) (USFWS, 2016).

**Taxonomy**

In the sunflower or daisy family (Asteraceae). Thomas Nuttall (1840) described Erigeron decumbens based on a specimen he collected in the summer of 1835. The autonym E. decumbens var. decumbens was automatically established by Cronquist (1947) when he described E. decumbens var. robustior. Recent revisions of the Erigeron genus (Strother and Ferlatte 1988, Nesom 1989) treat the plant as a variety, E. decumbens var. decumbens. According to Strother and Ferlatte (1988), E. decumbens var. decumbens is geographically limited to the Willamette Valley and the morphologically similar E. decumbens var. robustior is restricted to Humboldt and western Trinity Counties, California. (USFWS, 2010).

**Historical Range**

See current range/distribution.

**Current Range**

Occurs only in the southern end of the Willamette Valley, Oregon. Historically had ranged further north near Portland. Generalized range of 7400 sq. km. (USFWS, 2016)

**Critical Habitat Designated**

Yes; 11/30/2006.

**Legal Description**

On October 31, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 30, 2006) for Erigeron decumbens var. decumbens (Willamette daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Oregon and Washington (71 FR 63862-63977).

**Critical Habitat Designation**

The critical habitat designation for Erigeron decumbens var. decumbens includes nine CHUs in Benton, Lane, Linn, Marion, and Polk Counties, Oregon. This species critical habitat encompasses approximately 718 ac (291 ha). Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule (71 FR 63862-63977; USFWS, 2006).

Units WD–1A and 1B encompass approximately 41.2 ac (16.7 ha) of Federal land occurring in northern Polk County. This unit is located adjacent to Highway 22, approximately 5.6 mi (9 km) northeast of the City of Dallas.

Unit 2 for Erigeron decumbens var. decumbens (Unit WD–2) Unit WD–2 encompasses approximately 12.2 ac (4.9 ha) of private land occurring in southern Marion County. This unit occurs south of SE Triumph Road and east of SE Boedigheimer Road.

Unit WD–3 encompasses approximately 58.3 ac (23.6 ha) of private land occurring within northern Linn County. This site is located north of SE Kingston Lyons Drive and on both the east and west sides of Huntly Road, and is primarily owned by TNC.

Unit WD–4 encompasses approximately 9.3 ac (3.8 ha) of private and City of Corvallis land occurring in Benton County. This unit is located north of SW Reservoir Avenue and south of NW Oak Creek Drive. Approximately half of the habitat within this unit is located on City of Corvallis land and half on private land.

Unit WD–5 consists of approximately 38.5 ac (15.6 ha) of private land, south of Corvallis, in Benton County. This unit is located along Muddy Creek, just to the west of Cutler Lane.

Unit WD–6 encompasses approximately 85.4 ac (34.6 ha) of critical habitat, with an estimated 89 percent on Federal land and 11 percent occurring on private land. This unit is located in Eugene, along Ken Neilsen Road and West 11th Avenue. The federally owned land includes both BLM and Army Corp of Engineers lands.

Unit WD–7A consists of approximately 22.3 ac (9 ha) of critical habitat, primarily on Federal land, with 2 percent occurring on private land. WD–7A is located to the west of Green Hill Road and to the north of West 11th Avenue, and is managed by the Army Corp of Engineers.

Subunits WD–8A and 8B consist of approximately 135.9 ac (55 ha) of Federal and private lands in West Eugene, Oregon. These subunits are located near the intersection of Willow Creek and West 18th Avenue. An estimated 45 percent of this area occurs on private land with approximately 55 percent occurring on BLM land.

Subunit WD–9A encompasses an estimated 90 ac (36.4 ha) of private land and is located approximately 1.2 mi (2 km) east of the intersection of Pine Grove Road and Crow Road.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Erigeron decumbens var. decumbens critical habitat consists of one component (71 FR 63862-63977):

(i) Early seral upland prairie, wet prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils.

**Special Management Considerations or Protections**

Because Erigeron decumbens var. decumbens does not tolerate the presence of woody vegetation, habitat management will be required for the long-term persistence of this species. Further investigation is needed to determine the most appropriate techniques for managing available habitat. Also, due to the low reproductive capability of the species, conservation of the E. decumbens var. decumbens will likely depend on artificially augmenting populations in areas where woody vegetation has been removed (Clark 2000, pp. 9-10). (USFWS, 2006)

Expanding Erigeron decumbens var. decumbens populations will require more investigation into the roles of sexual and vegetative reproduction of this species. If sexual reproduction proves to be most important for population recruitment, mangers will need to focus on strategies that promote flowering, seed production, and seedling establishment (Clark 2000, p. 9). However, if vegetative regeneration is predominant, managers will need to focus on activities that promote ramet (refers to individual plants in a clump, each portion of which is identical with the original parent plant) production (Clark 2000, p. 9). Clark et al. (1995b, pp. 22-23) found that vegetative propagation is a viable technique for E. decumbens var. decumbens; populations may also be increased by sowing seeds under appropriate conditions, although this technique appeared to be less effective than vegetative propagation. (USFWS, 2006)

Erigeron decumbens var. decumbens is at risk of inbreeding depression and site extirpation across their respective ranges because populations are small and isolated from one another. This species will benefit from reestablishing prairie plant patches in proximity to core populations. (USFWS, 2006)

Many remaining populations of Erigeron decumbens var. decumbens populations occur in road rights of ways and are adversely affected by maintenance activities such as mowing or spraying of herbicides at the wrong time of year. (USFWS, 2006)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2016)

**Breeding Season**

Adult: The Willamette daisy typically flowers throughout June and July (USFWS, 2016)

**Reproduction Narrative**

Adult: The Willamette daisy typically flowers throughout June and July with pollination carried out by syphrid flies and solitary bees (Clark et al.1995). The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August. The seeds of the daisy are achenes, like those of other Erigeron species, and have a number of small capillary bristles (the pappus) attached to the top, which allow them to be distributed by the wind. Due to the small size and number of these bristles, the seeds do not fly well in the wind, so seed distribution is quite restricted. The Willamette daisy is capable of spreading vegetatively through rhizomes over very short distances of less than 10 cm (4 inches) and is commonly found in large clumps scattered throughout a site (Clark et al.1993). Willamette daisy responds positively to late spring and early summer rains. Studies conducted at the Willow Creek Preserve indicate that not all individuals of the Willamette daisy bloom every year, and that some individuals may remain dormant for an entire growing season (Kagan and Yamamoto 1987) (USFWS, 2016).

**Habitat Type**

Adult: Vally Prairie (USFWS, 2016)

**Environmental Specificity**

Adult: Narrow. Specialist or community with key requirements common. (Natureserve, 2015)

**Habitat Narrative**

Adult: The Willamette daisy is typically occurs where woody cover is nearly absent and where herbaceous vegetation is low in stature (Clark et al.1993; USFWS 2010a). It occurs in both wet prairie grasslands and drier upland prairie sites. The wet prairie grassland community, which was historically maintained by periodic flooding and fires, is characterized by the dominance of tufted-hairgrass, California oatgrass, and a number of Willamette Valley endemic forbs. It is a flat, open, seasonally wet prairie with bare soil between the pedestals created by the bunching Deschampsia cespitosa (Kagan and Yamamoto 1987). On drier upland prairie sites, associated species commonly include Symphotrichum hallii, Festuca idahoensis ssp. roemeri and Toxicodendron diversilobum (Meinke 1982, Clark et al.1993). Willamette daisy prefers heavier soils, and has been found on the following soil associations: Bashaw, Briedwell, Chehulpum, Dayton, Dixonville, Dupee, Hazelair, Marcola, Natroy, Nekia, Pengra, Philomath, Salkum, Saturn, Stayton, and Witzel (USFWS, 2016).

***Dispersal/Migration***

**Dispersal**

Adult: Wind dispersed (USFWS, 2016)

**Dispersal/Migration Narrative**

Adult: The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August (USFWS, 2016).

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015; USFWS, 2016)

**Number of Populations:**

17 (USFWS, 2016)

**Population Size:**

1000 - 10,000 individuals (NatureServe, 2015)

**Population Narrative:**

The Willamette daisy is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of Willamette daisy throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980 (Clark et al.1993). The species was rediscovered in 1980 in Lane County, Oregon. At the time of listing, 28 occurrences of Willamette daisy were recognized with a total of 286 acres of occupied habitat (USFWS 2000). In 2010, the total acreage considered to be occupied was 233 at 39 sites (USFWS 2010a). In 2010, Willamette daisy was believed to be extant at 37 sites that comprise 17 populations (USFWS 2010b). Of these, 3 populations had been augmented and Willamette daisy had been introduced to 5 new sites since the time of listing. Three of the extant populations are the direct result of recent introductions, and 5 natural populations have been discovered since the time of listing. Willamette daisy is believed to be extirpated or the status is unknown at 11 sites where it was previously documented. Of these sites, 8 were known at the time of listing, including 5 that represented individual populations and 3 that likely contributed to larger populations. Current population estimates are based on available information from 2004 to 2010 (USFWS 2010b). For most sites, long-term data needed to detect population trends is not available. In some cases, documentation of the number of plants at a site is not available. Where sites are within 3 km (2 miles) of each other, they are generally considered to be subpopulations that comprise a larger population (i.e., metapopulation) based on pollinator travel distance (USFWS 2010a). Of the 17 currently known populations, only 2 include protected sites that support relatively large subpopulations (i.e., with over 2,000 plants) known to have been stable for 8 years or more (USFWS 2010b). Trend data is not available for most sites, and many sites are not formally protected. Recovery criteria outlined for downlisting have not been met in any of the recovery zones. Almost all previously identified threats to the species still remain. Significant progress has been made to store genetic material, and efforts to collect and store seed will likely continue. Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 Willamette daisy plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye and Brandt 2005). The population at Baskett Butte declined to 48% of the original measured population between 1993 and 1999 (Clark 2000; Clark et al.1995). Detecting trends in Willamette daisy populations is complicated by the biology and phenology of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of irregular emergence and sporadic flowering from year to year. They suggested that some plants probably lie dormant during some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark et al.(1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Like many native species endemic to Willamette Valley prairies, the Willamette daisy is threatened by habitat loss due to urban and agricultural development (USFWS, 2016).

**Stressor:** Encroachment/woody succession (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat

**Narrative:** Secondary successional encroachment of habitat by trees and brush is a threat to this species (USFWS, 2016).

**Stressor:** Competition (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Competition with non-native weeds is listed as a threat to this species (USFWS, 2016).

**Stressor:** Small populations (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Extinction/lack of genetic diversity
**Narrative:** Small population sizes (Kagan and Yamamoto 1987, Clark et al.1993) are listed as a threat to this species (USFWS, 2016).

**Stressor:** Private land (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The Service (USFWS 2000) estimated that habitat loss is occurring at 80% of remaining 84 remnants of native prairies occupied by Willamette daisy and Kincaid's lupine. The Service (USFWS 2000) also stated that 24 of the 28 extant Willamette daisy populations occur on private lands and, "without further action, are expected to be lost in the near future."

***Recovery***

**Reclassification Criteria:**
1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. Subpopulations contributing to larger interacting populations should be within pollinator flight distance (3 kilometers [2 miles]) of each other. See Table IV-3 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 10 years. The term "stable" in this context does not mean that the population size is static over time; over a period of 10 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1 above must meet these criteria: (a) Prairie quality. Sites supporting populations of the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (e.g., nest sites and food plants) for native pollinators. See Appendix D of the Recovery Plan for suggested criteria for evaluating prairie quality and diversity. (b) Security of habitat. For each

listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species. (c) Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with Sidalcea nelsoniana or Lupinus sulphureus ssp. kincaidii should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species. (USFWS, 2010)

Recovery Priority Number: 2C

**Delisting Criteria:**
Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-3 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 2 above must meet these criteria: (a) Prairie quality. Same as Downlisting Criterion 1. (b) Security of habitat. Same as Downlisting Criterion 1. (c) Management, monitoring, and control of threats. Same as Downlisting Criterion 1. (USFWS, 2010)

4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and

provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

**Recovery Actions:**

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)
- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)
- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)
- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group

of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans, data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)

- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)
- Recommendation for Future Action from 2019 5-Year Review: Action 1: Survey and Monitor: • Maintain information about what is currently known about the locations of extant and extirpated sites. •Maintain map with historical and extant populations and potential introduction sites. •Survey known and potential extant populations where status of populations or possible extirpation is unknown; identify and assess factors that appear to be driving population trends at occupied sites. • Monitor key populations and identify factors that may be driving population trends at occupied sites. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 2: Habitat Protection, Management and Restoration: • Select populations and lands on which to focus protection, management and restoration recovery actions. • Work with landowners to restore, manage and reduce threats to significant sites. • Work with partners to explore and develop opportunities to protect key populations on private lands. • Work to secure significant unprotected sites. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 3: Seed Collection, Propagation and Banking: • Continue on-going seed collection efforts for propagation and banking. • Identify sites for additional seed collection. • Increase seed availability through

cultivation and propagation at facilities that can manage genetic diversity and any necessary isolation. (USFWS, 2019)

- Recommendation for Future Action from 2019 5-Year Review: Action 4: Research: • Conduct demographic studies to determine how Willamette daisy responds to restoration and management treatments. •Research genetic and reproductive biology questions related to progeny fitness, demographic trends and the breeding system for use in developing seed transfer and augmentation guidelines, and to evaluate inbreeding depression concerns. •Research effects of climate change and voles on Willamette daisy populations and develop recommendations for responses to these threats. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 5: Augment Small Populations and Reintroduce Willamette Daisy to Suitable Habitats: • Identify protected populations that would be likely to benefit from augmentation and suitable habitats in strategic locations between secure populations that could be used as reintroduction sites. • Implement augmentation projects; develop management plans with landowners, as needed. • Implement (re)introduction projects; develop management plans with landowners, as needed. (USFWS, 2019)

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# SPECIES ACCOUNT: *Eriodictyon altissimum* (Indian Knob mountain balm)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 1/17/1995; California/Nevada (Region 8)

**Physical Description**

Indian Knob mountainbalm (Eriodictyon altissimum) is a narrowly endemic, perennial shrub in the Namaceae (nama) family. It grows up to 5.5 meters (m or 18 feet [ft]) tall. Indian Knob mountainbalm has dark green, linear leaves with revolute (strongly rolled under) margins. The inflorescences are scorpioid cymes, where the oldest flower in the arrangement terminates the main axis and continues to branch and curl over in a one-sided coil, like a scorpions' spiraling tail. The individual flowers occur on pedicels, are purple, and are funnelform in shape with five lobes (USFWS, 2024)

**Taxonomy**

First collected on Indian Knob by Philip V Wellsin 1960, and was described by him two years later (Wells 1962). In the waterleaf family (Hydrophyllaceae). (USFWS, 1998) Recognized by Kartesz (1994 checklist and 1999 floristic synthesis); Kartesz notes (pers. comm. to Larry Morse, 25Nov99) that "this appears to be a large-flowered expression of Eriodictylon angustifolium, but is probably worthy of recognition as a species." Skinner and Pavlik (1994) note that its taxonomic relationship to E. angustifolium needs clarification. The 2nd edition of The Jepson Manual (Baldwin et al. 2012) accepts it as distinct. (NatureServe, 2015)

**Historical Range**

Endemic to western San Luis Obispo County, California (USFWS, 2019b)

**Current Range**

Known from sevel locations in San Luis Obispo County, California (USFWS, 2019b)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual and asexual (USFWS, 1998)

**Lifespan**

Adult: Long-lived (USFWS, 1998)

**Breeding Season**

Adult: March to July (USFWS, 2024)

**Other Reproductive Information**

Adult: Indian Knob mountainbalm blooms March through July. It has capsule fruits with four valves (and two separate chambers), and most members of the genus generally produce many seeds (Hannan 2021, website; Keil 2022, pp. 555–556). However, seed production in Indian Knob mountainbalm is considered low to absent. The species has both above-ground stems and underground rhizomes. A single genetic individual can spread vegetatively via the rhizomes, producing a colony (genet) of identical above-ground stems ([ramets], Guilliams and Hasenstab-Lehman 2021, pp. 1–2). This clonality can pose challenges in the field when trying to assess the actual number of individuals present in a given stand because groupings of Indian Knob mountainbalm ramets likely contain few distinct individuals (USFWS, 2024).

**Reproduction Narrative**

Adult: The Indian Knob mountain balm is believed to be relatively long-lived; slow-growing lichens can be found attached to its woody stems. Fruits contain a single ovule and seed set is low in those plants in which it has been recorded (John Chesnut, pers. comm. 1997). It is not known if Indian Knob mountain balm is self-compatible; however, it is possible that some colonies are also composed of a single clone. In addition to sexual reproduction, this species regenerates by root sprouts. (USFWS, 1998)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Prefers sandstone ridges (NatureServe, 2015)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 1998)

**Habitat Narrative**

Adult: Indian Knob mountain balm occurs in soils derived from marine sandstones containing tar deposits referred to as “tarsands” and, in the northern part of its range, on Baywoodfine sands and weathered ancient dune soils. This species co-occurs with Morro manzanita in several locations in maritime chaparral. Vanderwier (1987) did a detailed study ofthe chaparral and oak woodland communities at the type locality forIndian Knob mountain balm. (USFWS, 1998). Indian Knob mountainbalm occurs on sandstone substrates largely derived from ancient sand dunes within the San Luis Range, in western San Luis Obispo County, California. It occurs in maritime chaparral habitat types, where it is a local component of these plant communities originating from the Indian Knob landform (located roughly north-northeast of the City of Pismo Beach). This landform is located between the cities of San Luis Obispo and Pismo Beach. Its range extends from the community of Los Osos, roughly southeast to the City of Pismo Beach (USFWS, 2024)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**
Stable (USFWS, 2009)

**Number of Populations:**
5 extant (USFWS, 2024)

**Population Size:**
>6,400 individuals in 2016 (USFWS, 2019b)

**Population Narrative:**
In 2019, Indian Knob mountainbalm is still known from seven occurrences, six of which are in protected areas and one (the largest) mostly in a protected area, with a total population count of 6,489+ individuals in 2016. Two occurrences are likely extirpated. A figure is available in the 5-Year Review depicting known geographic distributin in western San Luis Obispo County, California. One new occurrence (Occurrence 8) is new. (USFWS, 2019b). Indian Knob mountainbalm is currently known from six EOs (CNDDB 2024b, website), and 20 georeferenceable herbarium specimens from CCH2 (CCH2 2024, website). Of the six EOs, we presume one is likely extirpated (EO number 3, see p. 7; CNDDB 2024b, website). We are not able to ascertain the status of Indian Knob mountainbalm at the CCH2 documented locations. We also lack updated census or survey information to report about the species abundance throughout its range and are unable to assess population status trends, even at the spatial scale of individual occurrences (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, loss of habitat due to development, surface mining, and oil well drilling was identified as the primary threat to Eriodictyon altissimum. Since the time of listing, the threat of habitat loss due to development in the Los Osos area and surface mining, and oil well drilling in and around Indian Knob has been reduced to the point that we no longer consider this to be a significant threat to the species. The populations outside of Montaña de Oro State Park, with the exception of element occurrence 1 (Broderson), are now protected. Element occurrences 4 and 6 now are found within a Department ecological reserve and the majority of the plants in occurrence 5 (Indian Knob) are protected under a conservation easement held by the City of San Luis Obispo. (USFWS, 2009)

**Stressor:** Non-native invasive plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Modification of habitat due to the spread of invasive, non-native plant species was also a concern at the time of listing. Absent site-specific information from the implementation of management and monitoring programs, it is difficult to determine the actual severity of invasive, non-native species. No management plans or monitoring programs have been developed and implemented to detect change on conserved lands. Absent the type of information that would be collected and analyzed as part of such programs, it is not possible for us to determine if the occurrences are being adversely affected by competition from non-native invasive plant species. It does appear from anecdotal observations that all occurrences (except element occurrence 1) are stable and have not been significantly affected by competition from non-native invasive plant species. At element occurrence 1, veldt grass (Ehrharta calycina) appears to be degrading habitat, but its effect on Eriodictyon altissimum is unknown. (USFWS, 2009)

**Stressor:** Stochastic extinction (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, we did not discuss stochastic extinction as a threat. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, although the plants are long-lived, the small sizes of all but the Indian Knob population may make it difficult for those populations to persist if conditions are not suitable for the establishment of new individuals. (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species’ distributions will shift in response to climate change and that the species will “move” or disperse to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result “…in new species mixes, with consequent novel patterns of competition and other biotic interactions…” with unknown consequences to the species which currently exist there (Loarie et al. 2008). While, we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Eriodictyon altissimum; small ranged species, such as E. altissimum, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

***Recovery***

**Reclassification Criteria:**
1. At least five occurrences from throughout its range are on lands secure from human-induced threats. (USFWS, 1998)

2. Surrounding habitat is protected in amounts adequate to permit management of the vegetation community using prescribed fire, if it is deemed beneficial to the species. (USFWS, 1998)

3. Populations are projected to be self-sustaining and either stable or increasing as determined by long-term monitoring and research results. (USFWS, 1998)

**Delisting Criteria:**
When the downlisting criteria have been met for a species, the species can be considered for delisting if:

1. Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) integrate, or find a replacement for, a fire regime as a means of revitalizing declining or senescing colonies; b) manage adjacent shrub habitat through thinning to provide sufficient space for the species to expand in numbers, and c) educational signing to deter the public from cutting shrubs along trails; (USFWS, 2019a)

2. The occurrences remain viable for at least 15 years to demonstrate long-term viability under a range of environmental conditions. Rangewide surveys in 2016 and 2017 provide a baseline for numbers of stems or individuals, and in some cases, additional information regarding vigor of individuals, as measured by size. These data should provide a basis for monitoring occurrence attributes to determine viability over time; (USFWS, 2019a)

3. An ex situ collection of plant material is established in a Center for Plant Conservation-affiliated botanic garden. A soil seedbank would typically provide a strategy for a species to regenerate populations in the face of stochastic events as well as natural senescence. However, this species is suspected to have low seed production. Research on seed production and viability will be undertaken in the near future. Whether reproduction through banked seed proves to be efficacious or not, reproduction through vegetative propagation (e.g. cuttings) also holds potential as a means of replenishing occurrences, should it be necessary in the future. (USFWS, 2019a)

**Recovery Actions:**
- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)

- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendations for Future Actions from 2019 5-Year Review:  Little is known about the biology and ecology of Indian Knob mountainbaim in 2019. Therefore, coordinated conservation and research are needed to further understand the species, and to restore and maintain the five extant occurrences. These efforts should include: • Management actions to benefit the occurrences. • Searches for additional locations. • Introduction of Indian Knob mountainbalm into living collections at botanic gardens. • Seed collection for seed banking, with a subset of seeds used to investigate germination requirements, including cues associated with fire-following species. • Collection and cultivation of cuttings along with seeds to develop protocols for propagation of the species. • Studies of genetic diversity and reproductive biology, potential barriers to recruitment, and the species' relationship with fire. In particular, genetic diversity within and among the occurrences should be investigated. (USFWS, 2019b)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access to all six known Indian Knob mountainbalm occurrences (CNDDB 2024b, website) to conduct comprehensive surveys of abundance, assess the overall status of the species, and evaluate current threats to the species at each location. Include estimates of the total number of Indian Knob mountainbalm individuals present at each location, using the metric provided in Guilliams and Hasenstab-Lehman 2021 (pp. 17–18) and map the total occupied area using global positioning system (GPS). Collect other pertinent ecological and demographic data including cooccurring and co-dominant species, estimate of canopy cover, presence and abundance of nonnative, invasive species, timing of phenology, and observations of any potential insect pollinators. Provide data and interpreted findings to the Service and CDFW to ensure that resource databases and species relevant updates remain both accurate and current. 2. Conduct experimental research to better understand Indian Knob mountainbalm's reproductive biology. Specifically, investigate germination cues related to fire, seed bank dynamics, and seed viability. We also need to better understand why seed production is low to near absent, in wild populations and which environmental cues or conditions may stimulate production of seed. 3. Conduct experimental research to determine the most effective/optimal management techniques to apply to extant, wild populations of Indian Knob mountainbalm to ensure both persistence and expansion of the species within currently occupied areas. In particular, we must evaluate the use of prescribed burns and other disturbance techniques to stimulate new plant growth and regenerate senescent stands. 4. Work with partners who own or hold conservation easements on occupied Indian Knob mountainbalm sites and help them develop and implement conservation and recovery actions through habitat management plans for their properties. Support these partners and assist them to acquire and secure adequate funding and other endowments to manage the species and its habitat for conservation and recovery in perpetuity. 5. Conduct introductions at suitable sites that include long-term management strategies to ensure success and persistence of the species at introduced locations. Develop protocols for propagation of the species from both cuttings and seed. 6. Make adequate accessions of Indian Knob mountainbalm seed for conservation banking so that all known occurrences are represented in the established collections. Conduct seed bulking activities, if feasible, to have an ample source of seed for recovery efforts and to serve as a backup in the event of stochastic loss and possible extirpation (USFWS, 2024).

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# SPECIES ACCOUNT: *Eriodictyon capitatum* (Lompoc yerba santa)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/20/2000; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

An evergreen shrub, growing to about 3 m tall with narrow, leathery leaves. Lavender flowers are tubular, borne in head-like, densely hairy clusters. Blooms May-August. (NatureServe, 2015)

**Taxonomy**

Since the time of listing, a phylogenetic study provided evidence supporting the transfer of the genus Eriodictyon from the waterleaf family (Hydrophyllaceae) to the borage family (Boraginaceae) (Jepson Online Interchange 2010). (USFWS, 2011)

**Historical Range**

According to records available through the CNDDB (2010) and the Consortium of California Herbaria (Consortium) (2010), all historical collections and unvouchered observations of Eriodictyon capitatum are from the southwestern corner of Santa Barbara County. Other studies (Elam 1994, Jacks et al. 1984) recognized seven populations of E. capitatum based on the number of “Element Occurrences” (occurrences) at the time and as defined by CNDDB criteria. five populations are from three geographically distinct areas referred to here as Solomon Hills, west Burton Mesa, and Santa Ynez Mountains (USFWS, 2011)

**Current Range**

Eriodictyon capitatum is endemic to southwestern Santa Barbara County, California. It is found in three areas of the county: on Vandenberg Air Force Base, on the west crest of the Santa Ynez Mountains on Hollister Ranch, and on Graciosa Ridge in the Solomon Hills southeast of Orcutt. The entire range extent covers about 365 sq mi. (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 11/7/2002.

**Legal Description**

On November 7, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriodictyon capitatum (Lompoc yerba santa) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (67 FR 67968-68001).

**Critical Habitat Designation**

The critical habitat designation for Eriodictyon capitatum includes three CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 9,709 acres (67 FR 67968-68001).

**Primary Constituent Elements/Physical or Biological Features**

The primary constituent elements of critical habitat for Eriodictyon capitatum are the habitat components that provide: (i) Soils with a large component of sand and that tend to be acidic; and (ii) Plant communities that support associated species, including maritime chaparral, particularly where the following associated species are found: Dendromecon rigida (bush poppy), Quercus berberidifolia (California scrub oak), Quercus parvula (Santa Cruz Island scrub oak), and Ceanothus cuneatus (buck brush); and in southern bishop pine forests that intergrade with chaparral Arctostaphylos spp. (manzanita) and Salvia mellifera (black sage). (67 FR 67968-68001):

**Special Management Considerations or Protections**

Special management considerations or protections may be needed to maintain the primary constituent elements for the two taxa within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites, and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two taxa. We have outlined below the kinds of special management and protection that these two taxa would most likely require. These recommendations for management and protection are general in nature. Specific management actions should be developed according to local site conditions. Not all of these will apply to each plant taxon equally. (1) Existing soil conditions should be protected by avoiding activities that cause the erosion or compaction of soils. Maintaining an intact soil profile may be necessary to maintain edaphic features such as a horizon of permeable sandy soils on the surface layer. For example, Deinandra increscens ssp. villosa is thought to be restricted to acidic, fine sandy loams with a subsurface clay layer that may act as a reservoir of soil moisture. (2) Existing hydrologic conditions should be protected by avoiding activities that cause a change in surface or subsurface water flows upon which the plant taxa depend. For example, development of areas adjacent to a population may result in an increase in runoff and surface water flow. This alteration may affect the soil moisture content to which the local population has adapted. (3) In all plant communities where these taxa occur, invasive, non-native species, such as harding grass (Phalaris aquaticus), veldt grass (Ehrharta calycina), and iceplant (Carpobrotus edulis), should be actively managed. Invasive non-natives pose a serious threat to the survival of Deinandra increscens ssp. villosa and Eriodictyon capitatum and remaining habitat of the taxa. For example, accumulated dead leaves and stems (thatch) from nonnative grass species that dominate the habitat effectively prevent the establishment of D. increscens ssp. villosa at a site. Iceplant is known to invade native maritime chaparral vegetation occupied by Eriodictyon capitatum. Once non-native grasses and other invasive plants (e.g., iceplant) have become established, they cannot be removed without great expenditure of time and effort. (4) The composition of the native plant and animal communities associated with the taxa must be maintained. Native plant diversity may limit the ability of aggressive non-native plants to invade a population (Dukes 2002). In addition, a decline in biodiversity may increase the potential impact of invasive plants on a community (e.g., suppression of growth). Recent research suggests that grassland communities with fewer species may be more likely to decline as a consequence of invasion (Dukes 2001). In addition, native plant diversity may increase pollinator activity and therefore enhance the conservation of a plant species. Biologists have suggested that a plant population may persist as long as it occurs within an area of a diversity of plant species that are attractive to pollinators (Kwak 1988). Habitat fragmentation and isolation of species-rich grasslands, with intervening areas of no or low diversity of native plants, has been found to negatively affect plant-pollinator interactions (Stephann-Dewenter and Tscharntke 1999). (5) The local distribution of plant communities should be managed to provide for the physical requirements of the taxa (e.g., space for establishment). For some grassland areas, it may be important to maintain openings within or between coastal scrub communities that might otherwise encroach upon grassland patches that support Deinandra increscens ssp. villosa. (6) Certain areas where these taxa occur may need fencing to protect them from accidental or intentional trampling by humans and livestock. Portions of three of the five units are currently used by livestock

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (outcrossing) and asexual (vegetative) (USFWS, 2011)

**Dependency on Other Individuals or Species**

Adult: While pollination ecology has not been specifically studied for E. capitatum, other Eriodictyon taxa are known to be pollinated by wasps, butterflies, and a variety of bee taxa, especially from the genera Anthophora, Bombus, Chelostoma, Hylaeus, Osmia, and Nomadopsis (Moldenke 1976). (USFWS, 2011)

**Breeding Season**

Adult: May to August (USFWS, 2011)

**Reproduction Narrative**

Adult: Eriodictyon capitatum is capable of both sexual and asexual reproduction. The importance of sexual reproduction in maintaining populations is unclear. Research indicates that E. capitatum is a self-incompatible species; intentionally cross-pollinated flowers produced a mean of 1.77 seeds per fruit, and intentionally self-pollinated flowers produced a mean of 0.03 seed per fruit (Elam 1994). This species spreads vegetatively through the production of rhizomes (underground stems), and thus producing colonies of ramets (genetically identical stems) from only a few individuals. The lavender flowers are tubular and clustered in heads that bloom from May to August. While pollination ecology has not been specifically studied for E. capitatum, other Eriodictyon taxa are known to be pollinated by wasps, butterflies, and a variety of bee taxa, especially from the genera Anthophora, Bombus, Chelostoma, Hylaeus, Osmia, and Nomadopsis (Moldenke 1976). (USFWS, 2011)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Shrubland/chaparral (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Highly acidic soils with high water-retaining capacity on inland sites (USFWS, 2011)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Eriodictyon capitatum occurs within two different habitat types. Near the coast, it occurs within maritime chaparral and coastal sage scrub on sandstone soils from the Orcutt, Marina, and Oceano series. In this habitat type, it typically occupies disturbed areas near roads or exposed ridgetops (Jacks et al. 1984). On sites that are farther inland, Eriodictyon capitatum is found on diatomaceous Monterey shales. The structurally dominant Pinus muricata is one species that occurs at these sites. These sites have characteristic soils that are highly acidic and have a high water-retaining capacity (Cole 1974). Eriodictyon capitatum apparently can tolerate and may be encouraged by minor disturbance (Savage 1978, CNPS 1987, Myers 1987). (USFWS, 2011; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Declining by 8.5% since 2006 (USFWS, 2011)

**Number of Populations:**

5 (USFWS, 2011)

**Population Size:**

1,520 (USFWS, 2011)

**Population Narrative:**

During surveys for E. capitatum, approximately 1,520 individuals were documented within known populations (SRS 2010). Overall, since 2006, there was an 8.5 percent decrease in the total number of individuals. This decline in the number of individuals has been attributed to low rainfall in previous years (SRS 2010). (USFWS, 2011)

***Threats and Stressors***

**Stressor:** Habitat degradation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The increased use of the launch facilities at Vandenberg AFB due to nationwide Department of Defense base closures was identified as a threat to this species at the time of its listing (Service 2000). According to the final listing rule (Service 2000), increased use of Vandenberg AFB would potentially result in the loss or alteration of Eriodictyon capitatum habitat. Wildfires were cited as one example of how habitat could be lost or altered. In 1993, debris from a missile that was intentionally destroyed shortly after launching caused several fires and burned more than 162 ha (400 ac). In September of 1997, a 200-ha (500-ac) fire and a 600-ha (1,500-ac) fire burned near habitat occupied by E. capitatum (Los Angeles Times 1997a). In November of 1997, a 495-ha (1,225-ac) fire was accidently started on Vandenberg AFB by an Air Force explosives disposal team and was partially contained by setting a backfire through a population of E. capitatum (Los Angeles Times 1997b). Although increased use of Vandenberg AFB could result in the loss or alteration of E. capitatum habitat (e.g., wildfires), the number of

launches per year is restricted. Habitat alteration and loss from development for military and commercial purposes was also identified as a threat to this species at the time of its listing (Service 2000). Habitat fragmentation within the Burton Mesa area continues. The original extent of Burton Mesa chaparral was approximately 9,000 ha (22,000 ac); by 1938, the extent had been reduced to 5,890 ha (14,554 ac), and by 1988, less than 3,500 ha remained (8,649 ac) (Davis et al. 1988). The only population of Eriodictyon capitatum on Vandenberg AFB that could be threatened by future development would be the 35th Street population. However, at this time, there are no plans to develop this area (Lum pers. comm. 2010). This population is also subject to disturbance from human activities because of its close proximity to paved and unpaved roads and the cantonment area. At present, it appears that the destruction and alteration of habitat due to an increased use of Vandenberg AFB remains a threat to E. capitatum. (USFWS, 2011)

**Stressor:** Non-native species (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** On Vandenberg AFB, Ehrharta calycina (veldt grass) was planted to stabilize sand dunes in the 1950s; with the aid of the prevailing onshore winds, it rapidly spread across Vandenberg AFB and onto Burton Mesa between 1979 and 1996 (Air Force 1996). This species spreads rapidly, both vegetatively and through a persistent seedbank, and is extremely difficult to eradicate once it has become established (Bossard et al. 2000). Carpobrotus edulis and C. chilensis are other nonnative species that threaten to alter the maritime chaparral habitat by forming dense mats (Odion et al. 1992). The Eriodictyon capitatum population located at 35th Street is the only population on Vandenberg AFB whose habitat is actively managed (e.g., removal of nonnative and invasive plant species). This population is located next to paved and unpaved roads and the cantonment area. Nonnative species such as Cortaderia jubata, Pinus radiata (Monterey pine), and Eucalyptus globulus (eucalyptus) have all invaded E. capitatum habitat in this area. The alteration of habitat due to an increase in nonnative species is still a threat to E. capitatum populations located on Vandenberg AFB. There is no information available on nonnative species that may threaten the populations of E. capitatum located in the Solomon Hills and Santa Ynez Mountains. (USFWS, 2011)

**Stressor:** Altered fire regime (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat for Eriodictyon capitatum may be altered by the increase in Ehrharta calycina and subsequent increases in the frequency of wildfires. Invasive plants such as E. calycina can change the fuel properties of a site, which can in turn affect fire behavior, and ultimately alter fire regime characteristics such as frequency, intensity, extent, and seasonality of fire. If the regime changes subsequently promote the dominance of the invaders, then an invasive plant-fire regime cycle may be established, and restoration to preinvasion conditions becomes more difficult (Brooks et al. 2004). Although the natural fire return interval is unknown, because of its low elevation and infrequent lightning strikes, it was probably greater than the 20 to 30-year fire return interval found across most of Vandenberg AFB (Hickson 1988). A shorter fire return interval than the one that naturally occurs could negatively impact native plant species by destroying plants before seed set occurs or destroying the seed bank. (USFWS, 2011)

**Stressor:** Oil extraction and energy activities (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although we did not discuss it in Factor A in the rule to list Eriodictyon capitatum, we discussed elsewhere in the rule that oil extraction and refinement (e.g., maintenance activities, hazardous waste cleanup) are activities taking place at the Solomon Hills site where this species occurs. Since the time of listing, several activities have been conducted within habitat for this species in the Solomon Hills. In 2007 and 2010, projects to maintain well pads and adjacent roads were undertaken by Breitburn Energy Company. The purpose of these projects was to trim or remove E. capitatum stems that had encroached onto cleared well pads, oil drilling and processing equipment, wells, power poles, and other areas. During such activities, only stems that are in areas where they pose a fire safety risk or operational constraint are removed. At this time, it does not appear that oil extraction and energy development activities are a threat to E. capitatum. (USFWS, 2011)

**Stressor:** Development of Hollister ranch (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While development on Hollister Ranch is considered low-density (approximately 50 single-family homes as of 2009), these residential homes are often associated with other development including accessory buildings, agricultural development, reservoirs and roads, all of which have increased the demand on limited water resources and have resulted in the alteration and degradation of portions of the natural landscape (County of Santa Barbara Planning and Development Department 2009). An undated botanical survey (Hollister Ranch Conservancy 2003) indicates that E. capitatum occurs on six contiguous parcels in the western portion of Hollister Ranch. Of these six parcels, an undeveloped parcel has been sold and a second parcel has a completed residence and is available for purchase (Hollister Ranch Realty 2010). All six of these parcels are located within designated critical habitat for the species and could be developed. Development on Hollister Ranch is regulated under CEQA and requires the lead agency (i.e., County of Santa Barbara) to avoid or mitigate a project's significant environmental impacts if alternatives or mitigation measures are feasible. However, determination of the adequacy of avoidance or mitigation strategies is at the discretion of the County of Santa Barbara. Therefore, we believe that development is a threat to the population of E. capitatum located on Hollister Ranch. (USFWS, 2011)

**Stressor:** Stochastic extinction (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As stated in the 2000 final listing rule, we continue to believe that the existence of five populations of Eriodictyon capitatum and the species' restricted distribution place this species at risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Groom et al. 2006; Primack 2006). This vulnerability can arise due to uncertainty with stochastic events, such as environmental stochasticity, natural

catastrophes, genetic stochasticity, and demographic stochasticity. Populations of E. capitatum are subject to all of these stochastic events. Elam (1994) found that two of the six populations she studied were uniclonal. Because E. capitatum is self-incompatible and cannot produce viable seed, a uniclonal population can be extirpated by both environmental stochasticity (e.g., prolonged drought) and natural catastrophes (e.g., wildfire). Furthermore, genetic stochasticity can result in a loss of genetic variation and subsequently decrease population viability. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, we did not discuss the potential effects of climate change on the long-term persistence of Eriodictyon capitatum. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to Eriodictyon capitatum at this time. (USFWS, 2011)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 11

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Recovery actions are not available.
- Complete a Recovery Outline and Species Action Plan for Eriodictyon capitatum as a first step in preparing a recovery plan for the species. (USFWS, 2011)
- Develop a survey protocol for Eriodictyon capitatum. Because of its clonal habit, surveyors may develop their own methods or may avoid counting the number of individuals. Creating a survey protocol would encourage documentation of the number of plants and would allow comparison across the species range. (USFWS, 2011)
- Work with representatives from Breitburn Energy Company, CDFG, and Hollister Ranch to ensure that management of their lands is consistent with the long-term persistence of Eriodictyon capitatum at those sites. In addition, maintain contact with these representatives to ensure that survey information is updated on a regular basis. (USFWS, 2011)
- Conduct genetic testing in collaboration with representatives from the Air Force, Breitburn Energy Company, CDFG, and Hollister Ranch. Genetic testing can determine if a population is uniclonal or multiclonal. This information could aid in developing appropriate

management decisions and conservation strategies for each population. (USFWS, 2011)
- Discuss with conservation experts if cross-pollination of uniclonal populations with multiclonal populations would be an appropriate management strategy to increase the amount of viable seed produced. This would aid in increasing genetic diversity within uniclonal populations. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Throughout this document, our own use of the word stem refers to all vertical vegetative parts including ramets. However, in our analysis of reports prepared by other observers, it was often impossible to determine the intended use of the words “stem,” “ramet,” “individual,” and “plant,” and it was often confusing and not consistent from one observer to the next (e.g., ManTech 2020a, p. 18). In accordance with IUCN (2014, p. 23–24) recommended guidelines for colonial and modular organisms, we recommend counting the number of all vertical stems (including ramets) and reporting that number as vertical stems along with a statement of this method. Little is known about the biology and ecology of Lompoc yerba santa in 2021. Therefore, coordinated conservation and research are needed to further understand the species, and to restore and maintain the 11 known occurrences. These efforts should include: • Implement management actions to reduce threats and benefit the occurrences of Lompoc yerba santa. • Conserve and protect habitat in vicinity of and near existing occurrences, with particular attention to maritime chaparral on Burton Mesa, Vandenberg Space Force Base. • Conduct searches for additional locations of Lompoc yerba santa, including use of helicopters and drones for searching large expanses of potential habitat and potential habitat in difficult terrain. Priority should be given to searching in vicinities of occurrences 12 (Jack and Laura Dangermond Preserve) and 13 (Upper LaSalle Canyon, Vandenberg Space Force Base). • Collect tissue samples from occurrence 12 for genetic analyses. • Continue seed collection for seed banking. In coordination with Santa Barbara Botanic Garden and contingent upon results of previous sampling, multicolonal locations should be visited to determine if seed production is occurring, in particular at occurrences 2, 13 and 14 as a matter of urgency (these three occurrences are on Vandenberg Space Force Base). • Collect and cultivate cuttings and seeds to develop protocols for propagation and outplanting for long-term restoration success. In consideration of the threat of climate change with severe drought and increased temperatures, the methods employed for outplanting in arid lands by Abella et al. (2012, entire), Abella et al. (2015, entire), Abella (2017, entire) and Abella et al. (2020, entire) should be considered. • Study genetic diversity and reproductive biology, pollinator network and potential network disruption, potential barriers to recruitment, and the species’ relationship with fire. • Introduce Lompoc yerba santa into living collections at botanic gardens. (USFWS, 2021)

**References**

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

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed June 2016.

USFWS. 2011. Eriodictyon capitatum (Lompoc yerba santa) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California

U.S. Fish and Wildlife Service. 2002. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Eriodictyon capitatum (Lompoc yerba santa) and Deinandra increscens ssp. villosa (Gaviota tarplant)

Final Rule. 67 FR 67968-68001 (November 7, 2002).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed 06/27/2016

USFWS. 2021. Lompoc yerba santa (Eriodictyon capitatum) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California. 30 pp.

# SPECIES ACCOUNT: *Eriogonum apricum (incl. var. prostratum)* (Ione (incl. Irish Hill) buckwheat)

***Species Taxonomic and Listing Information***

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

**Physical Description**

Low-growing, herbaceous perennial; Polygonaceae. (NatureServe, 2015)

**Historical Range**

Known only from an approximate 16-kilometer (km) (10-mile (mi)) stretch along the Ione Formation in western Amador County. Although little information is available to determine the historical extent of either E. apricum variety, and there has been a loss of natural occurrences within the range, the species still persists throughout its estimated historical range. All of the historical and current occurrences are between the village of Buena Vista in the south and Highway 16 in the north 6 (CNDDB 2008). At the time of listing, it was suggested that the range of E. apricum var. apricum may extend to cover portions of Sacramento County (Service 1999, p. 28406); however, surveys conducted in 2001 have placed all of the E. apricum var. apricum plants in Amador County (Service 2005, p. 15). (USFWS, 2010)

**Current Range**

Ione Formation, Amador Co, California. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Chaparral (Natureserve, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Coarse, very acidic, nutrient-poor soils with cement-like, iron oxide crusts (NatureServe, 2015).

**Environmental Specificity**

Adult: Very Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits coarse, very acidic, nutrient-poor soils with cement-like, iron oxide crusts. On these soils - developed under a tropical or subtropical climate 35-57 million years ago - a distinctive, low-growing chaparral community occurs, usually surrounded by taller, more common chaparral types. Eriogonum apricum is restricted to otherwise barren red clays within these "Ione chaparral" communities. Most populations occur between 90 and 280 m elevation.

(NatureServe, 2015)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

6 - 20 (NatureServe, 2015)

**Population Narrative:**

Occupies a total of approximately 4 hectares (Fish and Wildlife Service 1999). 6 sites ranked above C; 10 total EOs in NDDB. According to Fish and Wildlife Service (1999), there are nine occurrences. (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat to Eriogonum apricum habitat is mining for silica sand, clay, lignite, common sand and gravel. Development for commercial or residential development, clearing for agriculture, and fire protection are lesser threats (USFWS, 2010).

**Stressor:** Stochastic events and climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Events such as disease outbreaks, reproductive failure, extended drought, landslides, or a combination of several such events, could destroy part of a single population or entire populations. A local catastrophe could also decrease a population to so few individuals that the risk of extirpation due to genetic and demographic problems inherent to small populations would increase. Climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2010).

***Recovery***

**References**

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

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed June 2016.

USFWS 2010. Eriogonum apricum (inclusive of vars. apricum and prostratum) (Ione Buckwheat = Irish Hill Buckwheat) Arctostaphylos myrtifolia (Ione Manzanita) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California. Accessed June 2016.

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

USFWS. 2010. Eriogonum apricum (inclusive of vars. apricum and prostratum) (Ione Buckwheat = Irish Hill Buckwheat)

Arctostaphylos myrtifolia (Ione Manzanita)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 24 pp.

# SPECIES ACCOUNT: *Eriogonum codium* (Umtanum Desert buckwheat)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 05/23/2013; Pacific Region (Region 1) (USFWS, 2016)

**Physical Description**

A low, mat-forming woody perennial. Slow-growing and long-lived. Leaves are covered with dense white hairs. Flowers are yellow. (NatureServe, 2015)

**Taxonomy**

Species from Washington state published in: Reveal, J.L., Caplow, F.E., Beck, K.A. 1997. Eriogonum codium (Polygonaceae: Eriogonoideae), A new species from south-central Washington. Rhodora. 97: 350-356. (NatureServe, 2015)

**Historical Range**

Umtanum desert buckwheat was discovered in 1995 during a botanical survey of the Hanford installation (Reveal et al. 1995, p. 353). It is unknown if the historic distribution of Umtanum desert buckwheat was different than the species' current distribution, but it is likely the species has been confined to this location during at least the last 150 years (USFWS, 2013).

**Current Range**

One ridgeline, Benton County, southeastern Washington. (NatureServe, 2015) Found only on the Hanford Reach of the Columbia River. The only known population of Umtanum desert buckwheat occurs along the top edges of the steep slopes on Umtanum Ridge (USFWS, 2013).

**Critical Habitat Designated**

Yes; 12/20/2013.

**Legal Description**

On December 20, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriogonum codium (Umtanum Desert buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (78 FR 76995-77005; 78 FR 24008-24032).

**Critical Habitat Designation**

The critical habitat designation for Eriogonum codium includes one CHU in Benton County, Washington. This species critical habitat encompasses approximately 334 acres (ac) (139 hectares (ha)) (78 FR 76995-77005; 78 FR 24008-24032).

This critical habitat unit was mapped using Universal Transverse Mercator, Zone 11, North American Datum 1983 (UTM NAD 83) coordinates. These coordinates establish the vertices of the unit boundaries. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which the map is based are available to the public at the field office Internet site (http:// www.fws.gov/wafwo/HanfordPlants/ FLFCH.html), http:// www.regulations.gov at Docket No. FWS–R1–ES–2013–0012, and at the Service's Washington Fish and Wildlife Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum codium critical habitat consists of five components (78 FR 76995-77005; 78 FR 24008-24032):

(i) North- to northeast-facing, weathered basalt cliffs of the Wanapum Formation at the eastern end of Umtanum Ridge in Benton County that contain outcrops, cliff breaks, slopes, and flat or gently sloping cliff tops with exposed pebble and gravel soils.

(ii) Pebbly lithosol talus soils derived from surface weathering of the top of the Lolo Flow of the Priest Rapids Member of the Wanapum Formation.

(iii) Sparsely vegetated habitat (less than 10 percent total cover), containing low amounts of nonnative or invasive plant species (less than 1 percent cover).

(iv) The presence of insect pollinator species.

(v) The presence of native shrub steppe habitat within the effective pollinator distance (300 m (approximately 980 ft)) around the population.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Umtanum desert buckwheat. In all of the described units, special management may be required to ensure that the habitat is able to provide for the biological needs of the species. Further studies leading to an enhancement or reintroduction plan may be necessary to increase population size and prepare for recovery postwildfire. More research is needed to determine habitats most suitable for expansion of the current population. In summary, special management considerations or protections should address activities that would be most likely to result in the loss of Umtanum desert buckwheat plants or the disturbance, compaction, or other negative impacts to the species' habitat. These activities could include, but are not limited to, recreational activities and associated infrastructure, off-road vehicle activity, dispersed recreation, wildfire, and wildfire suppression activities. Special management considerations or protection will conserve the primary constituent elements for the species. Management activities that could ameliorate these threats include, but are not limited to, the fire management plan that has been completed for the Hanford installation (DOE 2011, p. 93) and recently revised to incorporate more detailed management objectives and standards. Though not intended to specifically address Umtanum desert buckwheat, implementation of this plan will contribute to the protection of the primary constituent elements (and physical or biological features) by: (1) Using a map of ''sensitive resources'' on the site during implementation, including the location of Umtanum desert buckwheat habitat; (2) requiring a biologist to assist the command staff in protecting these environments during wildfire suppression efforts; and (3) restricting public access to the entire Umtanum desert buckwheat site, including the pollinator use area. Public access without security clearance is currently prohibited at the Umtanum desert buckwheat site, reducing the risk of trampling or crushing the plants by ORV use. Special management to protect the designated critical habitat areas and the features essential to the conservation of Umtanum desert buckwheat from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the population and nearby plant community components. These actions may be achieved by detailed fire management planning by the DOE, including rapid response and mutual support agreements between the DOE, the Monument, the U.S. Department of the Army, Bureau of Land Management, and the Washington Department of Fish and Wildlife for wildfire control. These agreements should contain sufficient detail to identify actions by all partners necessary to protect habitat for Umtanum desert buckwheat from fire escaping from other ownerships.

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: Growth rates are also extremely slow, with stem diameters increasing an average of only 0.17 millimeters (mm) (0.007 in) per year (The Nature Conservancy (TNC) 1998, p. 9; Dunwiddie et al. 2001, p. 62) (USFWS, 2013).

**Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2013)

**Lifespan**

Adult: 100+ years (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2013)

**Reproduction Narrative**

Adult: Individual plants may exceed 100 years of age, based on counts of annual growth rings on cross sections of the main stems of recently dead plants. Preliminary counts indicate that seed set occurs in approximately 10 percent of flowers observed, potentially limiting reproductive capacity. Based on a pollinator exclusion study (Beck 1999, pp. 25–27), the species is probably capable of at least limited amounts of self-pollination, although the percentage of seed set in the absence of pollinators appears to be low. A variety of insect pollinators were observed on Umtanum desert buckwheat flowers, including ants, beetles, flies, spiders, moths and butterflies (TNC 1998, p. 8). Wasps from the families Vespidae and Typhiidae and a wasp from the species Criosciolia have been observed in the vicinity of Umtanum desert buckwheat, but not on the plant itself. A bumble bee, Bombus centralis, has been observed by Washington Department of Natural Resources (WDNR) specialists utilizing flowers of Umtanum desert buckwheat plants (Arnett 2011b, pers. comm.) (USFWS, 2013).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Cliff, grassland/herbaceous (NatureServe, 2015); scarp, scree (USFWS, 2013)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations between 335 and 390 meters (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

**Habitat Narrative**

Adult: Eriogonum codium is restricted to a particular basalt flow, growing on flat or gently sloping areas near the top of the steep basalt cliffs. This species is found at elevations between 335 and 390 meters (Washington Natural Heritage 2002). (NatureServe, 2015) As the basalt of the Lolo Flow weathers, a rocky soil type is formed that is classified as lithosol, a term describing the well-drained, shallow, generally stony soils over bedrock (Franklin and Dyrness 1973, p. 347), and talus slopes associated with eroding outcrops and cliffs. These cliffs (scarps) and loose rock at the base of cliffs or on slopes (defined as scree) are found along the crests and slopes of local hills and ridges, including east Umtanum Ridge, where Umtanum desert buckwheat occurs (USFWS, 2013).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2021)

**Population Growth Rate:**

Stable (NatureServe, 2015)

**Number of Populations:**

1 (3 sub-populations) (USFWS, 2022)

**Population Size:**

3,016 (USFWS, 2021)

**Additional Population-level Information:**

Estimates for the population reflect the number of vegetative and flowering plants. When monitoring began, five subpopulations were delineated by breaks in substrate exposure (Dunwiddie et al. 2000, p. 60). Due to additional plants being discovered, the five subpopulations were redefined as three separate subpopulations: East, Middle, and West. Monitoring methods have been inconsistent over the years, and it is widely accepted that the monitoring efforts from 1995 to 2011 did not include all of the outlying plant clusters. In fact, the larger counts in 1997, 2011, and 2019 are attributed to either refined counting techniques or the discovery of previously unknown plants and clusters (USFWS, 2022).

**Population Narrative:**

The single Umtanum desert buckwheat population is small and declining. The population has declined from a high of 5,228 plants in 1997 to a low of 3,016 plants in 2019. The Population Viability Analysis (PVA) model for Umtanum desert buckwheat reported an annual population growth rate of 0.9935 with low recruitment indicating that there are greater numbers of plant mortalities occurring than individuals being recruited into the population (Caplow et al. 2007). Therefore, there is a slow decline of less than 1 percent annually without accounting for stochastic events. The population size after stochastic events exhibited sharp declines of 17.7 percent in 1996 and 51.2 percent in 2017. Because the population is small and in decline, it is possible that a single catastrophic event could cause the extinction of the species. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** climate change represents a potential ongoing threat based on the best available information, more thorough investigations are needed to better understand the potential impacts of climate change to this species.

**Stressor:** Habitat destruction and modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Factors adversely affecting habitat of Umtanum Desert buckwheat include wildfire and associated firefighting activities, nonnative plant fuel sources that increase the availability of wildfire fues sources, and potentially wildfire suppression activities. Unauthorized livestock trespassing, prospecting, and off-road vehicle use represent potential threats, which appear to be presently reduced because of improved boundary integrity, access controls, fencing, and enforcement (USFWS, 2013).

**Stressor:** Predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Predation of seeds by ants and removal of flower heads by an unknown species has been observed by researchers during demographic monitoring trips. No Umtanum desert buckwheat seedlings have been observed successfully germinating or becoming established near ant colonies. Because seed predation and the removal of flowering structures could significantly reduce the reproductive potential of the species, which is already in gradual decline based on the results of the PVA, these activities are considered to be ongoing threats to Umtanum desert buckwheat (USFWS, 2013).

**Stressor:** Small population size and low recruitment (USFWS, 2013)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Umtanum desert buckwheat has a small population size and distribution, and suffers from low recruitment. These features make it particularly susceptible to potentially changing climate conditions. The lack of establishment and survival of seedlings is a threat, as few plants are becoming established as replacements for plants that die (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
Recovery priority number of 5

**Delisting Criteria:**
Draft desliting requirement 1. Six Umtanum desert buckwheat populations (USFWS, 2022)

Draft desliting requirement 2. Self-sustaining populations with an average size of 1,200 individuals for at least 15 years (USFWS, 2022)

Draft desliting requirement 3. Populations are in a matrix of native shrubsteppe habitat within effective pollinator distance of 300 meters and threats managed by partners with long-term management commitments (USFWS, 2022).

Draft desliting requirement 4. Populations are adequately protected from wildfire (USFWS, 2022)

Draft desliting requirement 5. Seed collections are established, stored, and maintained at seed banks (USFWS, 2022)

**Recovery Actions:**
- Not available.

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS • Recovery Action 1: Protect the extant population and reduce the risk from wildfire. Improve access to Umtanum Ridge for emergency activities and recovery actions. Implement habitat restoration activities within and adjacent to occupied habitat to reduce wildfire risk due to abundant invasive plants. • Recovery Action 2: Preserve and augment the extant population by connecting subpopulations and isolated individuals to increase reproductive rates. • Recovery Action 3: Identify potentially suitable habitat sites and survey for additional Umtanum desert buckwheat populations. • Recovery Action 4: In areas of suitable habitat, establish and/or identify at least five additional populations to increase the species' redundancy, representation, and resiliency. • Recovery Action 5: Monitor the rangewide population, track trends, and assess threats. Implement a rangewide monitoring protocol and determine population trends. Develop and implement a detailed monitoring plan to assess known threats and identify potential new threats to the species and its habitat. • Recovery Action 6: Study the species ecology and breeding system, factors limiting reproductive success, the effect of climate change, and the response to management actions to guide conservation efforts. • Recovery Action 7: Promote awareness and conservation of Umtanum desert buckwheat throughout its geographic range.

(USFWS, 2021)

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# SPECIES ACCOUNT: *Eriogonum gypsophilum* (Gypsum wild-buckwheat)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 02/19/1981; Southwest Region (R2) . Proposed for Delisting (USFWS, 2017).

**Physical Description**

This plant is a woody stemmed perennial that grows in dense clumps and is approximately 20 cm high. The leaves are dark green, thick, mainly hairless, 1.5 - 2.5 cm wide and often wider than long, attached at the base, and have an outline like a hen's egg or a kidney. In the. fall the leaves turn bright red. The yellow flowers, 1-2 mm long, and in a broad dense cluster, appear from May to July. (USFWS, 1984)

**Taxonomy**

This species was first collected by E. O. Wooton on August 6, 1909, and described by Wooton and Standley in 1913. There are many species in this genus but Eriogonum gypsophilum is not closely related to any other western species (Wooton and Standley 1913). (USFWS, 1984) Gypsum wild-buckwheat is a distinct species without synonyms or taxonomic controversy. (USFWS, 2016)

**Historical Range**

See Current Range.

**Current Range**

In Eddy County, New Mexico. (USFWS, 2016). Gypsum wild buckwheat is represented by populations at Seven Rivers Hills, Black River, Ben Slaughter Draw, and Hay Hollow, which comprise the species' 60.8 kilometer (km) (37.8 miles (mi)) range (USFWS, 2022).

**Critical Habitat Designated**

Yes; 2/18/1981.

**Legal Description**

On January 19, 1981, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 18, 1981) for Eriogonum gypsophilum (Gypsum wild-buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in New Mexico (46 FR 5730-5733).

**Critical Habitat Designation**

The critical habitat designation for Eriogonum gypsophilum includes one CHU in Eddy County, New Mexico. This species critical habitat encompasses approximately 130 acres. A map is included in the Final Rule (USFWS, 1981; USFWS, 1984).

New Mexico: Eddy County; T20S. R25E. Section 19: N½, N½ NE¼ SE¼, N½ NW¼ SE¼; and T20S, R24E. Section 24: N½ NE¼, N½ S½ NE¼, NE¼ NW¼, N½ SE¼ NW¼; gypsum soils.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum gypsophilum critical habitat are not listed but are thought to be the following (46 FR 5730-5733):

Gypsum soils.

**Special Management Considerations or Protections**

Any activity which would result in disturbance of the area where Eriogonum gypsophilum occurs would probably adversely modify the Critical Habitat. The long-term solution on how to best protect Eriogonum gypsophilum may be to develop a protection plan for the species, which would address and remove present threats. In this respect, Critical Habitat designation may affect Federal activities. The Water and Power Resources Service should include in their planning process for the Brantley Dam Project ways to insure the continued existence of Eriogonum gJpsophilum. These plans should address the problems of slumping of the gypsurm soils and ways to protect the habitat of the Eriogonum gypsophilum so that it is not used for any activity which would not be compatible with the plant's continued existence. The Bureau of Land Management may need to limit future stocking rates of cattle and offroad vehicle use in the small area where the Eriogonum gypsophiIum occurs. This increased planning and the steps required by these agencies should not constitute a large impact or hardship on either agency. (USFWS, 1981)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, asexual: vegetative (USFWS, 2007)

**Lifespan**

Adult: 2+ (inferred from USFWS, 2007)

**Breeding Season**

Adult: May - July (USFWS, 1984)

**Reproduction Narrative**

Adult: Gypsum wild buckwheat is a perennial species that reproduces both by producing seed and also asexually by producing clone rosettes from rhizomes or rootsprouts (USFWS, 2007). Flowers appear from May to July (USFWS, 1984).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grama grassland, creosote bush communities (NatureServe, 2015); Chihuahuan desert scrub (USFWS, 1984)

**Geographic or Habitat Restraints or Barriers**

Adult: 900 - 1,500 m elevation (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Patchy and linear (USFWS, 2007)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 2007)

**Habitat Narrative**

Adult: Inhabits open, gypsum in grama grassland, at about 1,500 m; semi-arid. Eroded gypsum clay hills and fans, creosote bush communities, 900-1,100 m (Flora of North America Editorial Committee 2005) (NatureServe, 2015). It occupies gypsum soils and gypsum outcrops of the Permian-age Castile Formation. Distribution of gypsum wild buckwheat plants within its populations is patchy and follows geographic patterns of suitable gypsum outcrops, which are generally elongate and narrow (USFWS, 2007). It occurs in the Chihuahuan region of the Desert Scrub Formation (Donart et al. 1978) (USFWS, 1984).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Number of Populations:**

4 (USFWS, 2022)

**Population Size:**

Estimated to be 50,548 individuals (USFWS, 2016)

**Additional Population-level Information:**

Distribution of gypsum wild-buckwheat plants within its populations is patchy and follows geographic patterns of suitable gypsum outcrops, which are generally elongate and narrow. The lengths of these occupied outcrops are approximately 2.7 kilometers (km) (1.7 miles (mi)) long for the Seven Rivers Hills population, 1.6 km (1 mi) long for the Black River population, and 3.5 km (2.2 mi) long for the Ben Slaughter Draw population. Patches of gypsum wild-buckwheat within populations are also relatively small. The area of occupied habitat is only 16.3 hectares (ha) (40.3 acres (ac)) at Seven Rivers Hills, little more than 11.9 ha (29.5 ac) at Black River, and 66.4 ha (164.1 acres) at Ben Slaughter Draw (including Hay Hollow) for a total range-wide extent of approximately 94.7 ha (233.9 ac) of habitat occupied by this species (Tonne 2005, Sivinski 2013). (USFWS, 2016)

**Population Narrative:**

Estimated numbers of individual plants are the three known locations are as follows: Seven Rivers Hills: 14,168; Black River: 16,660; Ben Slaughter Draw (including Hay Hollow): 19,720. Refined mapping techniques resulted in the delineation of 16.3 ha (40.3 ac) actually occupied by gypsum wild-buckwheat. This is a significant reduction from the approximately 44 ha (109 ac) of occupied habitat identified previously by Spellenberg (1977) and Knight (1993). It appears BLM and Knight used the approximately 109 acres of occupied habitat as the multiplier for an average density estimate, thereby overestimating this population. This original acreage estimate was the basis for the recovery criteria to maintain a population of 10,000 plants at Seven Rivers Hills designated critical habitat area. The Black River and Ben Slaughter Draw populations of gypsum wildbuckwheat also occur as discontinuous patches of plants on the gypsum outcrops. Knight (1993) used belt transects to determine average density of plants within the Black River habitat. He estimated 32 ha (80 ac) of occupied habitat to arrive at a population estimate of 45,280 plants (rosettes). Subsequent GPS mapping (Tonne 2005) of this population significantly reduced the area of occupied habitat on BLM and state- owned lands within this population (the private land portion of this population was not mapped by Tonne). The discrepancies between the population boundaries in Knight's 1993 map and Tonne's 2005 map are more likely the result of the more accurate methods (e.g., use of a Global Positioning System) employed by Tonne than an actual reduction of population coverage between 1993 and 2005. A combination of Knight's (1993) average density estimate of 0.14 plants per m2 (0.01 per ft2) and Tonne's map showing 11.9 ha (29.5 ac) of occupied habitat results in a minimum population number of 16,660 plants at Black River. This estimate may increase when the area of occupied habitat on the private land portion of this population is known. The largest population of gypsum wild-buckwheat occurs at Ben Slaughter Draw. Knight (1993) also sampled this population with belt transects to determine an average density of 0.03 plants per m2 (0.002 per feet2) within occupied habitat. He arrived at a population estimate of 47,233 plants (rosettes) on 117 ha (288 ac). Subsequent GPS mapping of this population conforms to the general population boundaries of Knight's 1993 map, but significantly decreased the occupied habitat area to a more precise 62.4 ha (154.1 acres) (Tonne 2005). A total population estimate of 18,720 plants is obtained by using Knight's 1993 average density estimate and Tonne's 2005 mapped area of occupied habitat. These calculations for Ben Slaughter Draw do not include the 2013 rediscovery of the Hay Hollow portion of the population that he estimated 1,000-1,500 plants across less than 4.0 ha (10.0 ac) (Sivinski 2013). (USFWS, 2016).  Gypsum wild buckwheat remains represented by few (4), small (1–21 ha (3–52 ac)), isolated (by 4.0–71.3 km (2.5–45.3 mi)) populations (see Table 2.1) (Service 2022, pp. 22, 42). These populations are not securely stable (they have average population growth rates below 1.00, and only Seven Rivers Hills currently has good viability) and are unable to rescue one another in the event of catastrophic decline (Service 2022, pp. 50, 103). Note, however, that current population growth rate results are from only two transition-year sets while ten or more consecutive transition year sets may be needed to draw inferences about population growth rates for species with pulsed recruitment (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Mineral extraction and development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** All gypsum wild-buckwheat habitats are within areas with high potential for fluid minerals leasing and extraction. Oil and gas well pads, roads, and pipelines are proliferating in this region of New Mexico. The BLM SMA on the designated critical habitat of the Seven Rivers Hills population presently eliminates this threat through the requirement of "no surface occupancy" for mineral leases within the designated critical habitat. Roads and pipelines associated with mineral development also must avoid this area. The Seven Rivers Hills SMA protects about 95 percent of the occupied habitat from this land use. SMAs with "no surface

occupancy" stipulations for oil and gas leases were also administratively placed on BLM jurisdictions containing gypsum wild-buckwheat habitats at the Black River and Ben Slaughter Draw populations in 1997 (BLM 1988, BLM 1997). These SMAs protect approximately 50 percent of the total habitat at Black River and Ben Slaughter Draw from oil and gas development (Tonne 2005). Approximately 65 percent of total habitat area in all three gypsum wild-buckwheat populations is presently protected from surface impacts associated with oil and gas development. Knight (1993) concluded that mineral development for oil and gas, and possibly gypsum, was the only serious potential threat to gypsum wild-buckwheat. At this time, surface disturbance associated with federal mineral development is very unlikely to occur on gypsum wild-buckwheat habitats within the BLM SMAs. Mineral development could potentially affect nearly 50 percent of the Black River population. The private land portion of the Black River population could also be impacted by future minerals development. However, about 50 percent of the Black River habitat, about 95 percent of the Seven Rivers Hills habitat, and approximately 50 percent of Ben Slaughter Draw habitats have been protected by the "no surface occupancy" stipulation of the BLM SMAs (Tonne 2005). Oil and gas may be leased on these lands, but must be extracted by directional drilling from outside the SMAs. Directional drilling allows a company to develop fluid minerals without needing to be directly above (vertical of) the target, meaning this technology may afford greater avoidance options for conserving sensitive habitats. Rights-of-ways for the roads and pipelines associated with oil and gas development must also avoid disturbance of the SMAs. The Seven Rivers Hills and Ben Slaughter Draw SMAs also requires the withdrawal of minerals, such as gypsum, sulfur and salts, from claim and mine development. Mineral claims are not specifically withdrawn from the Black River SMA. The chemical analysis found the gypsum of the Castile Formation to be 85 percent hydric gypsum, which is a suitable quality for mining (Weber and Kottlowski 1959, Knight 1993). Potential for gypsum mining of the Castile formation however, is low at this time because of large deposits of higher quality gypsum presently being mined elsewhere in New Mexico (Knight 1993). (USFWS, 2016)

**Stressor:** Reservoir Development and Flooding (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threat of flooding from Brantley Reservoir has not been fully realized, primarily due to the use of a spillway in the central section of the main dam (BOR 2009). The elevation of the spillway is 993.5 m (3,259.5 ft) mean sea level and the maximum water surface elevation of the reservoir is 1,006.9 m (3,303.5 ft) mean sea level. Water level peaked on March 29, 2015 (U.S. Geological Survey 2016) at approximately 4.0 m (13 ft) above the spillway at 997.5 m (3272.5 ft) elevation. Even at this highest level, the pool remained to the east of U.S. Highway 285 and the gypsum wild-buckwheat population. Knight (1993) analyzed the potential impacts from Brantley Reservoir reaching the maximum flood pool with the assumption that the water level would rise similarly across U.S. Highway 285. Under this assumption, the maximum flood event pool in Brantley Reservoir could temporarily flood a few hectares of gypsum wildbuckwheat habitat. He found eight gypsum wild-buckwheat plants at or below the 1,002.8 m (3,290 ft) level on the west side of U.S. Highway 285. The soils in this area would become saturated for a time after a flood and could potentially be invaded by saltcedar (Tamarix spp.), an invasive tree that often lines the banks of reservoirs. Knight surveyed another 6 m (20 ft) vertical up to the 1,009 m (3,310 ft) level where saltcedar might become established and located an additional 44 gypsum wild-buckwheat plants. In 1993, there were 52 plants in the hypothetical zone of maximum flood impact. A flood event could potentially impact about 100 plants in this

population of several thousand plants. However, at the highest water level recorded in 2015, the water did not reach U.S. Highway 285 and the gypsum wild-buckwheat was not impacted. Therefore, Brantley Reservoir is not a significant threat to gypsum wild-buckwheat. The populations at Black River and Ben Slaughter Draw are not near any existing or proposed reservoirs and therefore, are not threatened by flooding. The Seven Rivers Hills population is the only known population that could be affected by flooding. (USFWS, 2016)

**Stressor:** Drought (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Inadequate seasonally appropriate soil moisture is typically caused by drought and may be exacerbated by hydrological alteration (Factors A and E). Climate change projections for gypsum wild buckwheat's range predict increased temperatures (+2–5 °C (+4–9 °F)), and relatively unchanged precipitation (+3.8 to -6.6 millimeters (mm) (+0.15 to -0.26 inches (in))) through 2099 under representative concentration pathway RCP) scenarios 4.5 and 8.5, respectively. These changes would increase evaporation and drought, adversely affecting survival and recruitment of gypsum wild buckwheat plants. Gypsum wild buckwheat's tolerance of desiccation and ability to go dormant in response to soil moisture stress provides some resilience to climate change, but increases in the intensity, frequency, and/or duration of drought would likely stress this adaptive capacity. Increased drought may also lead to increased predation (Factor C) resulting from reduced availability of alternative preferred forage for herbivores. It is unknown if gypsum wild buckwheat's ability to obtain scarce nutrients and its strategies for surviving drought and herbivory can support self-sustaining wild populations through climate change (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 14

**Delisting Criteria:**
The criteria for delisting are based upon the designation of the critical habitat as a Bureau of Land Management (BLM) Area of Critical Environmental Concern (ACEC) to maintain the population of 10,000 individuals. Some other special use designation which would secure the area from degradation due to human activities would be acceptable. (USFWS, 1984)

**Recovery Actions:**
- Prevent further impacts by designating the critical habitat area as an ACEC; develop a management plan; manage livestock grazing and study its effects; regulate recreational use, including Off-Road Vehicle (ORV) traffic, in the habitat; and monitor the effects of raised water level in Brantley Reservoir (USFWS, 2016).
- Maintain healthy populations by studying gypsum wild buckwheat biology and habitat characteristics (USFWS, 2016).
- Inventory suitable habitats for new populations (USFWS, 2016).
- Develop public appreciation and support for gypsum wild buckwheat. (USFWS, 2016)

- Recommendation for Future Action from 2016 5-Year Review: Through Section 4 of the ESA, the Service is required to conduct a 12-month finding to review the petition request to delist the gypsum wild-buckwheat and concurrently propose to delist. A post-delisting monitoring plan will be developed and made available for public review and comment prior to a final rulemaking. (USFWS, 2016)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Direct Conservation Actions • Maintain and extend barricades that block motor vehicle access to occupied areas. Close vehicle access to populations and to linear features intersecting populations. • Increase avoidance distances to 300 m for all potentially adverse land use or treatment activities. Maintain avoidance distances over time and across land jurisdictions. • Expand the Hay Hollow population to increase occupied extent and area. For example, establish subpopulations of plants from at least 50 Hay Hollow-sourced maternal lines in suitable soils on the adjacent escarpments north and south of the current Hay Hollow population. • Discover and/or introduce populations that increase gypsum wild buckwheat's range extent and diversity of associated vegetation types, geological units, and climate zones. Research and Monitoring • Expand long-term demographic monitoring across land jurisdictions. Maintain monitoring plots and continue demographic studies until the average transition matrix from 10–15 consecutive years of data demonstrates a stable or increasing population growth rate. • Identify and document gypsum wild buckwheat seed germination and seedling establishment requirements. • Identify and document specifications for suitable gypsum wild buckwheat soils (e.g., soil testing for percent gypsum, other nutrients, and soil microorganisms; soil depth probing; etc.). • Proactively model, survey, and map suitable gypsum wild buckwheat soils. • Identify and document techniques for restoring the gypsum wild buckwheat suitability of compacted, hypergypsic soils. Building Community Support • Install and maintain signs that support education about, and enforcement of, current and existing protective land use designations. Stay ahead of emerging adverse recreational use trends. • Recruit and retain botanical expertise amongst agency environmental review and project management staff (USFWS, 2022).
- Discretionary conservation measures (including project clearance surveys, environmental review of potential impacts, and avoidance distances for surface disturbing activities) currently account for a significant proportion of gypsum wild buckwheat protections (77% of population areas are protected by discretionary conservation measures versus 40% of population areas by special land use designations). Since federal listing under the Act, gypsum wild buckwheat populations have been managed for conservation and expansion primarily through local stakeholder initiative and discretionary programs, practices, and funding. The comprehensive suite of discretionary conservation actions has been effective at minimizing risks from threats and maintaining the status of this species. However, discretionary conservation is vulnerable to rollbacks as budgets and/or administrative priorities change. They are also vulnerable to staff attrition and turn-over. If the species were delisted, continuation of these conservation actions would be uncertain in the absence of formalized administrative direction to retain them (USFWS, 2022).

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# SPECIES ACCOUNT: *Eriogonum longifolium var. gnaphalifolium* (Scrub buckwheat)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 5/27/1993; Southeast Region (R4)

**Physical Description**

Eriogonum longifolium var. gnaphalifolium is a perennial herb. It has a taproot and one to three above-ground stems up to 1 m tall, but upwards of 10 stems have been observed in vigorous specimens, especially post-fire. It has a basal rosette of leaves that are 15 to 20 cm long, narrow, and white-woolly on the underside. The stem leaves are smaller than the rosette leaves. The stem terminates in a corymb, with each branch of the corymb ending in a cup-shaped involucre that holds a cluster of 15 to 20 small flowers, with each flower hanging on its stalk down below the involucre. The involucre is silvery, silky-pubescent, and the flowers are green with pink anthers (Rickett 1967) (USFWS, 1999)

**Taxonomy**

The genus Eriogonum includes about 150 species, most of them in western North America. Florida has only two species, both native to high pineland. Eriogonum tomentosum is common throughout the northern part of the state, as far south as Highlands County. The second species, scrub buckwheat, was named Eriogonum floridanum by J.K. Small (1903). Subsequent publications on Florida?s flora consistently adopted Small?s treatment of E. floridanum as a full species (Small 1933, Kral 1983, Ward 1979, Wunderlin 1982), but James Reveal (1968), an expert on the genus, treats the Florida plants as a variety of Eriogonum longifolium, a widespread species of the Great Plains that is represented east of the Mississippi by var. harperi in northern Alabama, Tennessee, and Kentucky (Kral 1983), and by var. gnaphalifolium in Florida (USFWS, 1999).

**Historical Range**

In Florida, in the following counties: Highlands, Hillsborough, Lake, Orange, Osceola, Marion, Pasco, Polk, and Sumter (USFWS, 1996)

**Current Range**

In Florida, in the following counties: Highlands, Hillsborough, Lake, Orange, Osceola, Marion, Pasco, and Polk (USFWS, 1996; USFWS, 2018)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

**Lifespan**

Adult: Unknown (NatureServe, 2015)

**Breeding Season**

Adult: January to November (NatureServe, 2015); May - October (USFWS, 1999)

**Key Resources Needed for Breeding**

Adult: Disturbance or fire; hunting wasps and bees (NatureServe, 2015); open sand, moist soils (USFWS, 1999)

**Reproduction Narrative**

Adult: Eriogonum longifolium var. gnaphifolium is an herbaceous perennial that presumably is long-lived and slowly growing. It flowers and reproduces primarily after fires or other disturbances (e.g. logging, mowing) that increase light availability. Although it readily resprouts after fires or other disturbances such as mowing, it does not reproduce vegetatively. Flowering can occur from January to November, but is usually synchronized with fire or other disturbance; most flowering occurs within the first year after a fire. Although a plant is usually in flower for two to three months, the individual flowers are short-lived and open asyncronously. Typically, a maximum of one to two flowers per involucre are open at any one time. The flowers, although inconspicuous, must be insect-pollinated for seed set to occur. Several types of hunting wasps (families Vespidae, Eumenidae, Sphecoidea, Pompilidae) and a few bee species (Halictidae) visit the flowers. These insects, all with an excellent locational sense, may be "traplining" the plants daily for their nectar. Although the flowers provide a dependable source of nectar, it is thought that these insects are the only potential pollinators able to repeatedly located the scattered, inconspicuous flowers (Deyrup pers. communication). Seeds have no dormancy, but germinate only in microsites with little or no litter and sufficient moisture (Carrington unpubl. data). Virtually all seedling establishment, therefore, must occur within the first year after a fire; litter buildup is prohibitive afterwards. Seedling establishment tends to be rare, however, probably because moisture conditions are usually not optimal due to high soil surface temperatures and evaporation rates following growing season fires. Most seedling establishment probably occurs in very wet periods after fires. In the low-light conditions of long-undisturbed communities, Eriogonum longifolium var. gnaphifolium individuals are present as inconspicuous basal rosettes; flowering individuals are rare, and occur only in openings or on edges such as road shoulders or fire breaks (pers. obs.). Plants may be capable of surviving without leaves in undisturbed communities by subsisting on stored carbohydrates in their large roots; this possibility is suggested by the "sudden appearance" of previously undetected adult plants in populations monitored for several years (Menges pers. communication). Longevity of individuals is unknown, but since establishment from seed is extremely rare in long-unburned communities, populations may decline or vanish in sites unburned for several decades. Drought tolerance assumed from habitat. Reproduction is sexual (NatureServe, 2015). Although little information on the reproduction of this species is available, plants in the Ocala NF have been observed with immature flower stalks between April and mid-July and bloom from May to mid-October. Seedlings germinate in summer in open sand (R. Yahr, Archbold Biological Station, personal communication 1998) (USFWS, 1999).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: oak-hickory scrub, turkey oak barrens, and sandhill vegetation communitied on the Lake Wales Ridge (USFWS, 2018)

**Dependencies on Specific Environmental Elements**

Adult: 5 - 20 year fire intervals (USFWS, 2018)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2018)

**Habitat Narrative**

Adult: Scrub buckwheat occurs in oak-hickory scrub, turkey oak barrens, and sandhill vegetation communities on the Lake Wales Ridge from Highlands County north to Lake County. It is also found to a limited extent on the Mount Dora Ridge in the ONF in Marion County and on two parcels of private property in Orange County. Each of the vegetation communities where scrub buckwheat occurs evolved with periodic fire. Demographic modeling suggests population viability is highest when fire return intervals are 5 - 20 years (Satterthwaite et al. 2002) . Scrub buckwheat occurs in several xeric plant communities that may be burned at intervals of 1-8 years for sandhill to 5-12 years for oak-hickory scrub. On the ONF, scrub buckwheat occurs within actively harvested timber stands and habitats that are not managed specifically for timber production. (USFWS, 2018).

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Seeds have no obvious dispersal mechanism, and usually drop beneath the parent plant; some may be carried a short distance in runoff during a rain (NatureServe, 2015).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Unknown (USFWS, 2018)

**Number of Populations:**

67 extant (USFWS, 2023)

**Additional Population-level Information:**

A total of 93 E. longifolium var. gnaphalifolium EO records have been reported to FNAI since 1961. Based on FNAI’s most recent EO database (2022), there are 67 extant populations with over two-thirds occurring on conservation lands (USFWS, 2023).

**Population Narrative:**

The spatial distribution of scrub buckwheat has not changed from that reported in the 1996 recovery plan. However, additional populations have been located on properties that have been subsequently acquired for conservation purposes within the historic range. Turner et- al. (2006) indicated that there are 27 populations of scrub buckwheat on protected public and private lands and 21 populations on unprotected private lands. Scrub buckwheat populations that are located on unprotected lands are susceptible to extirpation because of land use changes. However, periodic censuses are not conducted and it is not possible to quantify the number or location of extirpations that have occurred due to habitat destruction. The Service is aware of two populations, both in Lake County, that have been extirpated due to issuance of incidental take permits under section 10 of the Endangered Species Act. (USFWS, 2018)

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Twenty-seven of the 48 known scrub buckwheat localities occur on private, local, State, or Federal lands that are protected. This number of sites is substantially higher than the nine protected sites specified in recovery criterion number 1. Habitat loss or modification due to land use changes is not anticipated at these 27 sites because most were acquired for conservation purposes. Nonetheless, simply protecting scrub buckwheat habitat is insufficient to ensure long-term persistence because, as discussed above, this species requires periodic habitat management actions. Except for those properties described above, we do not currently have information about the type or frequency of land management activities on public lands where scrub buckwheat occurs. However, in general, it is widely documented that most public land managing agencies have not been able to burn as many acres as are targeted in their management plans. Consequently, most agencies are backlogged in prescribed burning (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2008). Even though we know managing agencies are faced with difficulties in use of prescribed fire in general, we do not know whether specific areas that contain scrub buckwheat habitat on public lands are threatened with modification due to lack of management. - The 21 scrub buckwheat populations occurring on unprotected private lands are susceptible to degradation of habitat due to lack of management and destruction due to land use changes. Habitat degradation will likely continue on these lands because private landowners have no incentives to manage their properties for scrub buckwheat. Even though scrub buckwheat can persist for long periods in fire suppressed conditions, a reduction in flowering and seedling recruitment can be expected in long-unburned habitats (McConnell and Menges 2002, Satterthwaite et al. 2002, Menges 2007). These adverse effects are expected to continue into the future on unprotected and unmanaged parcels. In addition, urban development is projected to increase in Florida in the coming decades (Zwick and Carr 2006), and we expect a commensurate decline in native vegetation communities. Such assessments, however, cannot project absolute risks of habitat destruction, on a parcel-by-parcel basis. Consequently, while we acknowledge the future risks of destruction of unprotected scrub buckwheat populations, we do not know which, if any, of the 20 populations are imminently at risk. - As a result of land acquisition efforts over the past several decades by private entities and local, State, and Federal governments, 27 scrub buckwheat populations have been protected from habitat destruction and this level of conservation has exceeded recovery criterion 1 in the recovery plan, Even though 21 of the known populations of scrub buckwheat

are not secure and are vulnerable to destruction or decline, we believe the 77 protected populations represent an adequate number of conserved populations to ensure long-term persistence of this species if protected populations benefit from periodic management activities that create and maintain suitable scrub buckwheat habitat (see Recommendations for Future Actions). While each of the public lands containing scrub buckwheat may undertake management activities, we do not currently have information about what types of management or how frequently management occurs on most public lands. Consequently, scrub buckwheat may still be at risk from habitat modification due to lack of management, but we will not know the extent of this risk until we evaluate more thoroughly the historic and ongoing management actions on public lands (see Recommendations for Future Actions). (USFWS, 2018)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 15 (USFWS, 2023)

**Delisting Criteria:**
1. Complete planned land acquisitions (USFWS, 1996)

2. Protect at least one more site in Lake and/or Pasco counties (one site is protected in Pasco). Demographic monitoring in conjunction with habitat manipulation (prescribed fire or other measures) appears essential, so monitoring is needed for at least five years. (USFWS, 1996)

**Recovery Actions:**

- 1. Determine current distribution of E. longifolium var. gnaphalifolium. A survey has not been made of the Lake Wales Ridge for this species, making defining a complete distribution in South Florida difficult. (USFWS, 1999)
- 2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. (USFWS, 1999).
- 3. Continue research on life history characteristics of E. longifolium var. gnaphalifolium. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- 4. Continue monitoring the existing populations of E. longifolium var. gnaphalifolium. Evaluate the effectiveness of the monitoring protocol used to assess population trends for E. longifolium var. gnaphalifolium. Monitor and detect changes in demographic characteristics, such as growth, survival, mortality. Monitor the effects of various land management actions on E. longifolium var. gnaphalifolium. Continue to work with private landowners. Monitor introduced plants. Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole. (USFWS, 1999).
- It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed. Public outreach efforts must also continue to address the increasing concern that horticultural demand for rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial

production and horticultural uses of endangered species provide little benefit to species, since the recovery of E. longifolium var. gnaphalifolium and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999).

- Revise the recovery criteria to establish measurable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, and the demographic performance levels/rates that should be met (USFWS, 2018).
- Monitoring of scrub buckwheat populations should be initiated on the ONF to evaluate the response of scrub buckwheat to soil disturbances associated with timber harvesting/site preparation activities and to determine the status of the species on the ONF (USFWS, 2018).
- The demographic status of scrub buckwheat populations may be inferred with minimal additional information. We believe that information regarding the number of individual plants and land management history can allow for a reasonable estimation of the current demographic status of extant scrub buckwheat populations. In this regard, we do not currently know how many plants exist on 23 of the 27 public lands where records indicate scrub buckwheat occurs. Consequently we recommend that surveys be conducted on public lands where no count data are available. Surveys initiated soon after fire would be valuable in assessing post-fire response of scrub buckwheat. We also suggest that a synthesis be conducted of historic and ongoing management actions on the same parcels for which counts are conducted. Knowing the historic and ongoing management strategy will provide information about whether land management strategies are conducive to long-term persistence of scrub buckwheat. (USFWS, 2018)
- The use of temporally and spatially appropriate management actions (e.g., prescribed fire or other disturbance regime) in areas containing scrub buckwheat should be encouraged on all public lands (USFWS, 2018).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Conduct surveys on all conservation lands where the species is known to occur. Surveys should include locations of plants, estimate number of individuals, and general habitat conditions (i.e. recent habitat management, time since fire). Current survey information for populations are critical for future evaluations. • Establish a standardized monitoring protocol for consistency among populations and conservation lands (USFWS, 2023).

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# SPECIES ACCOUNT: *Eriogonum ovalifolium var. williamsiae* (Steamboat buckwheat)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/7/1986; Pacific Southwest (R8)

**Physical Description**

Steamboat buckwheat (Figure 2) is a low, densely matted, compact perennial herb, 0.5-4.5 dm across, with numerous, densely-leaved, woody branches. The above-ground portions of the plant arise from a shallow but stout, woody, reddish brown taproot (usually in older plants), or a shallow, fibrous, rhizomatous root system (in younger plants). Each plant bears numerous oval to reniform leaves congested in tight rosettes. Leaf blades are generally 3-8 mm, 5-10 mm wide, and are densely covered with greenish-white to tannish-white hairs. Some leaves exhibit a faint brown margin at maturity. Petioles are generally 3-6 mm long, woolly, and often wavy or curled. Inflorescences are borne on erect, partly woolly stems, up to 2.5 dm (10 in) long, and are enclosed in cone shaped involucres covered with densely-matted, woolly hairs. Five to eight involucres are clustered in a head at the top of each stem. Flowers are generally white with a central greenish-brown rib, turning pinkish-tan with age (Reveal 1981; Williams 1982). Blooms May-early June. (USFWS, 1995)

**Taxonomy**

Named for Margaret Williams (1917-2000). Genetic analysis by Archibald et al. (2001) revealed var. williamsiae has high genetic variability, with levels of variation similar to that typical of a widespread species rather than a narrow endemic; and that all six varieties (note: var. depressum, var. monarchense, var. ochroleucum, var. pansum, and var. vineum were not sampled for the study) are very similar allozymically with var. williamsiae being the most similar to the widespread var. ovalifolium. Also, although var. williamsiae and var. ovalifolium are morphologically distinct, their genetic similarity warrants further study to determine whether or not they should be treated as separate taxa. Further, evidence of male sterility in var. williamsiae plus other data led Archibald et al. (2001) to hypothesize that this taxon might be either a hybrid or undergoing cytoplasmic introgression. (NatureServe, 2015)

**Historical Range**

See Current Range.

**Current Range**

This species is known from a single population in Washoe County, Nevada, located approximately 10 miles south of Reno. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual and asexual (NatureServe, 2015)

**Dependency on Other Individuals or Species**

Adult: Flowers are visited by a diverse group of smallish insects including bees, wasps, flies, and butterflies (Archibald et al., 2001). Some observers have suggested that butterflies pollinate them and that ants disperse the seeds (Soper, 1987). (NatureServe, 2015)

**Breeding Season**

Adult: May to June (NatureServe, 2015)

**Reproduction Narrative**

Adult: The plant reproduces by seed and vegetative spread. Clonal propagation may be the primary mode of reproduction in Steamboat buckwheat, coupled with occasional occurrences of seed production through sexual recombination (Ten Knight, TNC and Jim Morefield, NNHP, pers. comm., May 19, 1994). Flowers are visited by a diverse group of smallish insects including bees, wasps, flies, and butterflies (Archibald et al., 2001). Some observers have suggested that butterflies pollinate them and that ants disperse the seeds (Soper, 1987). The plant can spread clonally by rhizomes, so individual genets are difficult to distinguish (Knight, 1993). It is gynodioecious and males are sterile, or female plants produce flowers whose stamens bear anthers that are either small, poorly developed and knob-like, or larger but flattened; neither type produces pollen. The flowers of hermaphroditic plants produce normal, plump anthers that produce pollen. These flowers are self-compatible, but require a pollinator (Archibald et al., 2001). Genotype frequencies indicate mating is random and cloning has been documented but the frequency of this occurrence is not known (Archibald et al., 2001). Individuals were transplanted to containers at the Nevada Division of Forestry nursery and produced seed successfully, suggesting that this species does not depend on the pollination services of a highly specific pollinator. (NatureServe, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Playa, salt flat (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: The species colonizes the deposits only after precipitation has leached high concentrations of sodium, potassium, and other soluble chemicals from the substrates. Moisture is derived from precipitation rather than spring sources. (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Largely restricted to moderately deep, siliceous hot springs deposits known as sinter. Over time, as soils accumulate and develop on the deposits, other species invade and eventually out-compete the buckwheat (USFWS, 1995). (NatureServe, 2015)

**Environmental Specificity**

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

**Tolerance Ranges/Thresholds**

Adult: Moderate (NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Open areas on the slopes of deep (approximately 25 m), dome-shaped, siliceous hot springs deposits in an area that has been intermittently geothermally active for the past 2.5 million years. It is largely restricted to moderately deep, siliceous hot springs deposits known as sinter which originated from the discharge of hot-spring waters and thermal ground water saturated with amorphous silica (USFWS, 1995). The species colonizes the deposits only after precipitation has leached high concentrations of sodium, potassium, and other soluble chemicals from the substrates. Moisture is derived from precipitation rather than spring sources. Over time, as soils accumulate and develop on the deposits, other species invade and eventually out-compete the buckwheat (USFWS, 1995). (NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Williams (1982) suggested that the seeds of Steamboat buckwheat are disseminated by wind. Viability of seeds may be quite low. (USFWS, 1995)

***Population Information and Trends***

**Population Trends:**

Uncertain (USFWS, 2019)

**Number of Populations:**

1 (USFWS, 2019)

**Population Size:**

See narrative; difficult to estimate (USFWS, 2019)

**Population Narrative:**

Various estimates of the abundance of Eriogonum ovalifolium var. williamsiae have been made over the 32 years since the plant was listed. These estimates have ranged from 10,000 to 15,000 individual plants in the final rule listing the species (Service 1986) to 85,000 plants by Knight (1997), to 200,000 plants by Morefield (2001). Knight 1993 noted that a precise enumeration of individual plants is infeasible because the species is rhizomatous and propagates primarily by vegetative runners. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** A substantial portion of the Steamboat buckwheat occurs on a private parcel adjacent to U.S. Highway 395, giving it high potential for commercial development. About 60 percent of this 12 ac (4.9 ha) parcel, labeled Moana Lane Nursery in Figure 1, is occupied habitat comprising an estimated 15 percent of the total occupied habitat for the Steamboat buckwheat and over 20 percent of the two-thirds of the entire population that occurs on private land; moreover, the habitat on this property is believed to support dense concentrations of the buckwheat based on observations of similar habitat on adjacent Ormat-leased lands. For these reasons, conservation of this habitat is considered integral to the recovery of the Steamboat buckwheat. The landowner has repeatedly expressed interest in protecting the property either through fee title acquisition or through a conservation easement. The Nevada Department of State Lands has indicated a willingness to accept the property and the NDF has agreed to manage it, but to date no funding has been available to secure this part of the population. Although this private property remains subject to the permitting requirements of NDF (see Factor D, Section II.C.2.d), the development of this property remains a potential threat. (USFWS, 2009)

**Stressor:** Cessation of hot spring activity (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As noted in the biological discussion above (Section II.C.1.e.), hot spring activity on the site has ceased, and while the complex geothermal system is still not well understood, the cause is likely related to numerous factors including geothermal production, drawdown of the regional groundwater table resulting from increased domestic and municipal use, and possible lack of recharge due to drought (BLM 1993). It should be noted, however, that surface flow has not reappeared despite several wet/dry climatic cycles since the latter conjecture was made. Nevertheless, there is currently adequate habitat to support a robust population of the Steamboat buckwheat, and while the cessation of sinter creation may pose a long-term threat to its persistence, the species' survival does not appear at current risk due to the cessation of hot spring activity. (USFWS, 2009)

**Stressor:** Mining (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An active mining claim exists on a portion of the population on BLM land, but seems unlikely to be developed while the surrounding private lands are in geothermal production. Therefore, mining does not appear to be a significant threat at this time and is unlikely to become significant while the geothermal plant remains in operation. (USFWS, 2009)

**Stressor:** Off-road vehicles (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-road vehicle use has been substantially reduced due to fencing of the industrial areas, vigilance of the geothermal facility staff, and the installation of a right-of-way fence along U.S. Highway 395 by NDOT. The geothermal facility has recently installed a locked gate along their main access road which limits unauthorized access from this point. Occasional off-road vehicle use, usually by motorcycle, still occurs via other access points, but does not constitute a

significant threat to the species. There is no evidence of recent refuse dumping in the area so this activity is no longer considered to be a significant threat. (USFWS, 2009)

**Stressor:** Moisture availability (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes in moisture availability were cited in the final rule based on observations that plants have been observed to die when more than normal moisture, presumably precipitation, is received. This led to speculation that off-road vehicle use and refuse dumping might alter moisture patterns, thereby affecting plants. As noted above, both off-road vehicle use and refuse dumping no longer pose a significant threat to the species. The possibility that geothermal test wells might contribute to changes in water regimes has been discussed above. Some alteration in water flow patterns may have resulted from road and/or facility construction, but their effects are unknown and unlikely to be significant because of their limited extent. (USFWS, 2009)

**Stressor:** Human activities (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Minor impacts continue to affect small numbers of individuals, usually in peripheral areas adjacent to the highway or industrial sites. For example, in 2002 the NDF reported that a Nevada Department of Transportation (NDOT) project resulted in the loss of one plant. In 2004, NDF reported the transplantation of four plants to avoid loss during construction of a pipeline and geothermal facility, the loss of one plant hit by a snow plow during a storm, and the killing of an estimated 15 plants which were driven over by a crew servicing a billboard. In 2005, NDF reported that NDOT had killed one plant during construction of a right-of-way fence. In 2006, NDF reported that a spill of drilling mud had impacted 107 plants, all of which survived. These impacts, individually or collectively, do not constitute a significant loss of habitat for this variety and are far below a level that would jeopardize its existence. The current transportation plan for the area developed by Washoe County proposes a road that would likely impact occupied habitat, but this action would be subject to permitting by NDF. (USFWS, 2009)

**Stressor:** Predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some of the poor seed production observed in this variety has been attributed to high seed predation by larvae of a lycaenid butterfly species in the genus Euphilotes (Tepedino et al. 2000, p. 9). However, seed tested by the Berry Botanical Garden has shown seed viability of less than 1 percent, which strongly suggests that other factors, including genetic incompatibility factors, may be more significant in limiting sexual reproduction (see, however, the results of seedling monitoring during 2006 discussed in II.C.1.a. above). At this time, there is no evidence that disease or seed predation are significant threats to the species. (USFWS, 2009)

**Stressor:** Narrow distribution and small population size (USFWS, 2009)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** The final rule listing the Steamboat buckwheat indicated that the narrow distribution and small population size of the Steamboat buckwheat may make it vulnerable to fire or other disturbance in its habitat, and that a loss of individuals may have adverse effects on the reproductive capacity and survival of the species. The vulnerability of the habitat to fire has been addressed above in Section II.C.1.e. in our discussion of weeds. While it appears that the sexual reproductive capacity of the plant is limited, the Steamboat buckwheat does appear to have increased slightly in total area and perhaps numbers due to the control of disturbances caused by public access. No long-term monitoring data are available to precisely evaluate the status of the species, but anecdotal evidence suggests that it has successfully established in disturbed areas where it previously was not present. In addition, areas in which ramets (a unit of clonal growth) were transplanted as mitigation for the original loss of habitat from the cooling tower facility appear to be self-maintaining. Either those ramets have been successful in maintaining individuals through asexual reproduction, or they are successfully reproducing seedlings, or both, in the mitigation areas. (USFWS, 2009)

**Stressor:** sinter deposition (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** We are also concerned about the long-term sustainability of Steamboat buckwheat habitat because sinter deposition associated with hot spring waters has temporarily or permanently ceased. This is likely due to numerous factors including geothermal production nearby, drawdown of the regional groundwater table resulting from increased domestic and municipal use, and possible lack of recharge due to drought (USFWS, 2022)

***Recovery***

**Reclassification Criteria:**
Downlisting for Eriogonum ovalifolium var. williamsiae can be considered when: (USFWS, 1995)

1. Protective conservation easements or fee acquisitions secure approximately 185 acres of occupied habitat currently in private ownership; (USFWS, 1995)

2. Cooperative agreements are established for approximately 80 acres of occupied public lands and approximately 37 acres of occupied State lands within a highway easement; (USFWS, 1995)

3. Comprehensive management plans have been developed and implemented on all occupied habitat. (USFWS, 1995)

Recovery Priority Number: 3

**Delisting Criteria:**
Delisting Recovery Criteria (amended recovery criteria) Delisting may be warranted when the current downlisting criteria have been met and the species exhibits sufficient resiliency, redundancy, and representation to support long-term viability.

1. Threats are reduced or eliminated so that the species is capable of persisting without substantial human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. Outstanding management needs include: a) implementing the monitoring protocol, b) updating and renewing the Steamboat Buckwheat Management Plan (Knight 1997), c) controlling competition with nonnative weeds, and d) exploring potential methods of restoration of geothermal processes that maintain and create habitat. (USFWS, 2019)

2. All size classes are represented, the population is increasing or stable, and management objectives identified in the monitoring protocol are achieved (Pavlik 2002, Pavlik and Stanton 2003). Monitoring objectives were developed to detect and document 1) trends in the numbers of Eriogonum ovalifolium var. williamsiae plants in characteristic habitats, 2) the frequency and contribution of episodic reproduction to population stability, and 3) successional changes in common species that comprise the plant community of Steamboat Hills. Monitoring objectives are as follows: (a) Eriogonum ovalifolium var. williamsiae in the Main Terrace and Central Drainage habitats are within ± 15% of their 2003 baseline levels after five and ten consecutive years of monitoring with a 95% level of confidence. (b) Eriogonum ovalifolium var. williamsiae in the Main Terrace and Central Drainage habitats each produce a significant cohort of seedlings (20% of the mean density in a given subpopulation in a given year is contributed by "seedlings") at least once during five consecutive years of monitoring (or twice in ten years) with a 95% level of confidence. (c) Total live absolute cover by subpopulations of common shrubs [e.g. Artemisia tridentata (sagebrush), Atriplex confertifolia (shadscale), Chrysothamnus nauseosus (rabbitbrush), Purshia tridentata (bitterbrush)], perennial grasses [e.g. Poa secunda (bluegrass), Leymus cinereus (Great Basin wildrye)], and weeds [e.g. Bromus tectorum (cheatgrass)], as well as E. ovalifolium var. williamsiae are within ± 15% of their 2003 baseline levels after five and ten consecutive years of monitoring with a 95% level of confidence. (USFWS, 2019)

3. The ex situ seedbank is maintained through the collection of fresh seed from Eriogonum ovalifolium var. williamsiae plants every 10 years. Collections that are spread over time produce lower extinction risk to wild populations, while maintaining a species' genetic variation within an ex situ seedbank (Menges et al. 2004). The ex situ seedbank is currently maintained with Center for Plant Conservation-affiliated botanic garden, the Rae Selling Berry Seed Bank and Plant Conservation Program at Portland State University (formally the Berry Botanic Garden). Currently, the ex situ seedbank holds approximately 23,000 viable seeds from collections made from 1992-1995 in long-term storage (i.e. freezer). In 1999, a germination trial on a sample of these seeds found greater than 70% germination (E. Guerrant, Rae Selling Berry Seed Bank, pers. comm. 2018a, E. Guerrant, unpubl. data, 2018b). (USFWS, 2019)

**Recovery Actions:**
- Protect Steamboat buckwheat habitats from adverse ohysical and biological modifications. The entire population of Steamboat buckwheat is restricted to approximately 100-1 50 ha (250-375 ac) of private and federally managed lands. Comprehensive management of Steamboat buckwheat will require development of a range-wide protection strategy in cooperation with the property owners, the BLM, FHWA, NDOT, and other concerned or knowledgeable entities such as NDF, NNHP, and TNC. (USFWS, 1995)
- Determine Steamboat buckwheat biology and habitat requirements. Maintenance of a viable, self-sustaining population of Steamboat buckwheat well into the future will require: 1) Implementation of a monitoring program for gauging population trends and habitat

conditions; and 2) new research on various aspects of the taxon's biology and habitat requirements. (USFWS, 1995)

- Provide public information and education. Recovery of Steamboat buckwheat will be dependent, in part, on the interest and willing cooperation of the private property owners and other members of the local community. An effective outreach program would help to deter negative sentiment for the recovery process and create an avenue for involvement and support among property owners, other members of the public, and the resource management agencies. (USFWS, 1995)
- Recommendation for Future Action from 2009 5-Year Review: The highest priority should be given to recovery criterion 1, i.e., securing conservation easements or fee acquisition of the estimated 66 percent of the habitat which occurs on private lands. Given the generally industrial nature of the private lands leased by the geothermal company from the Dorothy Towne Trust, the purchase of a conservation easement to secure these populations is likely to be the best option for these lands. The only other parcel of private land, roughly 12 ac (4.9 ha) in size with an estimated 7 ac (2.8 ha) of habitat, would most likely be best acquired in fee title and transferred to either Nevada Division of State Lands or the BLM, with a subsequent recovery management agreement for the entire population to be developed with the NDF or other interested entity. Once the recovery management agreement, with adequate provisions for adaptive management, is in place, the species could be proposed for delisting. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: (optional, but may be helpful to identify priorities for management actions and information needs for next 5-year review) We updated the Recovery Plan for Steamboat buckwheat through a Recovery Plan Amendment in 2019. In the Recovery Plan Amendment, we synthesized the adequacy of the existing recovery criteria, outlined amended recovery criteria, the rationale supporting the recovery plan modification, and analyses of the most recent monitoring data. Future actions for this species should focus on downlisting and delisting recovery criteria such as: protective conservation easements or fee acquisition of occupied habitat in private ownership, updating or developing conservation or management plans and/or cooperative agreements, and reducing threats such as nonnative, invasive species (USFWS, 2022).

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# SPECIES ACCOUNT: *Eriogonum pelinophilum* (Clay-Loving wild buckwheat)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/13/1984; Mountain- Prairie Region (R6) (USFWS, 2015)

**Physical Description**

A low, stout, perennial herb, 5-10 cm high, with narrow, inrolled leaves that look like green scrolls. Clusters of white or cream-colored flowers with a rounded greenish-red to brownish-red perianth borne at the ends of the branches (NatureServe, 2015).

**Taxonomy**

The species was first recognized as its own taxon in 1969, and officially described by James Reveal in 1973 (Reveal 1969, pp. 75-76; 1973, pp. 120-122). The Eriogonum genus has undergone rapid evolution in the arid regions of the West, with roughly 250 species. This native North American genus is second only to Penstemon (beardtongue) in number of species (Reveal 2005a, p. 1) (USFWS, 2009).

**Historical Range**

Eriogonum pelinophilum was first collected near Hotchkiss, Colorado, in Delta County in 1958. Eriogonum pelinophilum is endemic to the rolling clay (adobe) hills and flats immediately adjacent to the communities of Delta and Montrose, Colorado (USFWS, 2009).

**Current Range**

Estimated range is 420 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences. Imprecisely reported occurrences are not included (NatureServe, 2015). The plants extend from near Lazear, east of Delta on the northern end of the species' range, to the southeastern edge of Montrose in Delta and Montrose Counties, Colorado (USFWS, 2009). Clay-loving wild buckwheat extends from just west of Lazear, Colorado on the northern end of the species' range, to the southeastern edge of Montrose on the southern end of the species' range (USFWS, 2022)

**Critical Habitat Designated**

Yes; 7/13/1984.

**Legal Description**

On July 13, 1984, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriogonum pelinophilum (Clay-Loving wild buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Colorado (49 FR 28562-28565).

**Critical Habitat Designation**

The critical habitat designation for Eriogonum pelinophilum includes one CHU in Delta County, Colorado. This species critical habitat encompasses approximately 119.8 acres (49 FR 28562-28565).

Colorado, Delta County. About 3 miles east of Austin near Highway 92. T14S, R94W 6th P.M. Section 26-west 225 feet of Section 26 lying south of State Highway 92 (5.6 acres). Section 27-that part of the SE¼ SE¼ lying south of State Highway 92 (35.6 acres]. Section 34-an area bounded by a line beginning at the northeast comer of Section 34, thence south along the section line 200 feet to a point; thence southwesterly to a point 1050 feet south and 550 feet west of the northeast comer of Section 34; thence southwesterly to a point 700 feet north and 900 feet east of center ¼ corner of Section 34; thence westerly 900 feet to the north-south ¼ line; thence northerly 600 feet along the ¼ line to a point; thence northeasterly to a point of the east 1/16 line; thence northerly along the 1/16 line 300 feet to the north section line of Section 34; thence easterly along the north section line to the point of beginning (65.0 acres). Section 35-north 200 feet of the west 225 feet (1.0 acres]. Section 27-west 200 feet of Section 27 lying south of State Highway 92 (4.3 acres]. Section 28-east 400 feet of Section 28 lying south of State Highway 92 (8.3 acres). Total 119.8 acres.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum pelinophilum critical habitat are not specified but are thought to be the following (49 FR 28562-28565):

The primary constituent elements include those factors associated with the whitish alkaline clay soils within the sparsely vegetated badlands of Mancos shale.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination, self-pollination (NatureServe, 2015)

**Lifespan**

Adult: 50+ years (inferred from NatureServe, 2015)

**Breeding Season**

Adult: May - September (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2022)

**Reproduction Narrative**

Adult: E. pelinophilum requires an insect pollinator in order to set seed (Bowlin et al. 1993). Experimental study showed that the species is self-compatible (sets viable seed when pollen is transferred between flowers on the same plant); the authors believe that "pollinators moving from male-stage to female-stage flowers on the same plant will occasionally effect pollination" (Bowlin et al. 1993). Pollinators also frequently move between plants, resulting in a mixed breeding system with some pollination from other flowers on the same plant and some from flowers on different plants (Bowlin et al. 1993). A wide variety of insects visit and probably pollinate the flowers. Both ants and flying insects appear to be effective pollinators, with a field experiment showing no significant difference in seed set among flowers visited only by ants, only by flying insects, or by both groups (Bowlin et al. 1993). Results from the Colorado Natural Areas Program (CNAP) monitoring program on E. pelinophilum (1987, 1988) indicate that E. pelinophilum is a long-lived perennial with a probable population turnover rate of approximately 20-50 years. All Eriogonum species studied thus far have seeds that require a cold period to break dormancy (not necessarily a freeze). Mixed selfing and outcrossing occurs (NatureServe, 2015). Flowering typically occurs from late May to early September with individual flowers lasting fewer than 3 days (Bowlin et al.1992, p. 298) (USFWS, 2009). Over 50 species of insects visit clay-loving wild buckwheat flowers (Bowlin et al. 1992, p. 300; Tepedino et al. 2011, p. 60). Roughly half of these species are native bees, and 18 species are native ants. Seed set is similar between plants pollinated by ants and plants pollinated by flying pollinators, which suggests that ants are important pollinators of the species (Bowlin et al. 1992, p. 298). Some fruits are removed by harvester ants, but no information suggests this is a major dispersal mechanism. (USFWS, 2022)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Salt desert shrubland (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 1580 - 1950 m elevation (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: 75 - 500 individuals per acre (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Eriogonum pelinophilum is found in substrates derived from the Mancos Formation shales. Inhabits whitish, alkaline clay soils on Mancos shale. Vegetation is a sparse salt desert shrub community. Occurs at 1580 - 1950 m elevation. The entire area is typified by rolling adobe (clay) hills and flats. Generally, the plants are found in a sharply defined soil microhabitat with shadscale (Atriplex confertifolia), on mid to lower slopes of the hills. The soil types are part of the Billings Series, known for its fine texture and weak and unstable structure. These soils are calcareous throughout and in some places have visible accumulations of calcium carbonate or calcium sulfate (Cline et al. 1967). Because of the low moisture availability, communities in which E. pelinophilum occur are characterized by low species diversity, low productivity and minimal canopy cover. Eriogonum pelinophilum is codominant with other xerophytic shrubs or subshrubs such as shadscale, the rare Penstemon retrorsus, Castle Valley clover (Atriplex cuneata), mat saltbush, black sagebrush (Artemesia nova) and Xylorhiza venusta (Neely 1985, O'Kane 1985). The communities are apparently stable, climax associations, judging from the lack of invading species capable of dominating the sites. Densities range from 75 - 500 individuals per acre (180 per acre average) (NatureServe, 2015). Eriogonum pelinophilum plants are generally found within swales or drainages that are moister than surrounding areas (USFWS, 2009). Clay-loving wild buckwheat extends from just west of Lazear, Colorado on the northern end of the species’ range, to the southeastern edge of Montrose on the southern end of the species' range (Figure 3). The plant occurs at elevations of 5,180 to 6,350 feet (ft) (1,580 to 1,940 meters [m]). (USFWS, 2022)

***Dispersal/Migration***

**Dispersal**

Adult: Low (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Most seed is dispersed locally (Bowlin et al. 1993). Seed dispersal is usually passive, either being consumed or carried by animals, windblown, or moved by gravity or water (NatureServe, 2015). Some fruits are removed by harvester ants (Bowlin et al. 1992, p. 299); however, no information is available for the species on seed dispersal mechanisms (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Species Trends:**

Relatively stable (NatureServe, 2015)

**Number of Populations:**

15 (USFWS, 2022)

**Population Size:**

~278,000 (USFWS, 2009)

**Adaptability:**

High (inferred from NatureServe, 2015)

**Population Narrative:**

Appears to be susceptible to impacts from grazing. Eriogonum pelinophilum appears to be a long-lived plant, with a calculated half-life of nearly 200 years (Carpenter and Schultz 1994). However, it is facing extreme pressure from residential and agricultural development, and occurrences have been extirpated. The long term population trend is unknown. The short term trend is relatively stable. The total area occupied by the mapped occurrences is 959 acres (calculated by the Colorado Natural Heritage Program in 2012). There are 9 occurrences with good or excellent viability (NatureServe, 2015). Today, the species is known from 12 existing (extant) Eos 2 additional populations. The most recent rangewide population estimate for all A through D ranked Eriogonum pelinophilum EOs is very roughly 278,000 individuals across 582 occupied ac (233 ha). Genetic variation has not been studied and, therefore, is unknown. When a rectangle is drawn around all known occurrences, it measures roughly 11.5 mi (18.5 km) from east to west and 28.5 mi (46 km) from north to south (CNHP 2009, spatial data) (USFWS, 2009). When clay-loving wild buckwheat was first listed, the species was known from only one site with roughly 10,000 individuals at the northern end of the species' currently known range (49 FR 28562; Figure 1). Since the species' listing, increases in survey effort have discovered more occurrences of the plant. Clay-loving wild buckwheat is now known to exist across 15 occurrences (Figure 2) and potentially exists at six additional historical occurrences. Despite the discovery of new occurrences, annual monitoring efforts by the Bureau of Land Management (BLM) have documented declines in plant density across the species' range (BLM 2021, entire), particularly over the last five years. Some occurrences experienced declines greater than 70 percent when compared to estimated densities from 2013 (BLM 2021, p. 5). (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Agricultural, urban, and residential development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The growing human population means more houses, more subdivisions, more industrial development, and increased utility and transportation needs that could impact Eriogonum pelinophilum occurrences as well as its suitable habitat. All EOs near Olathe and Montrose (EOs 004, 006, 011, 012, 013, 016, 018, 021, 022, 024, and 041) have agricultural fields or development immediately adjacent suggesting that some habitat and plants were lost when these areas were developed. The North Selig, Selig, Peach Valley, East, South, and Loutzenhizer Canals are all large canals that run along the eastern side of the Uncompahgre Valley and through Eriogonum pelinophilum habitat. Because of their proximity to E. pelinophilum EOs, suitable habitat and plants were likely lost during the construction of these canals. All canals and laterals have roads on at least one side, and most have roads running along both sides. These canals and associated roads support nonnative invasive plants and provide conduits for their spread. To reduce salt loading, a salinity control program was initiated in 1990. This program first eliminated flow through the canals during the winter and is now working to line laterals (Bureau of Reclamation 1994, summary). Because many of the E. pelinophilum EOs are located along laterals that are prioritized for lining, further impact to the species from these activities is a possibility. Increasing development continues to fragment and impact Eriogonum pelinophilum and its habitat. This development includes residential and industrial buildings, agricultural fields, power lines, canals, and roads (USFWS, 2009).

**Stressor:** Off-road vehicle use (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Aside from the direct loss of Eriogonum pelinophilum individuals, cars, motorcycles, and ORVs (collectively ORVs) may impact E. pelinophilum habitat in several ways. One common effect is soil compaction, which diminishes water infiltration, destroys soil stabilizers, and increases erosion from water and wind (ORV effects summarized in Ouren et al. 2007, pp. 1-225). Because of decreased soil moisture and increased compaction, plant size is generally reduced. Soil compaction also increases the potential for invasive, nonnative annuals and other early successional plants to establish rapidly in ORV routes. Other impacts such as edge effects, fragmentation, and dust impacts occur from ORV use. The Mancos shale soils are vulnerable to ORV impacts because the clay is especially vulnerable to compaction and because there are no rocks and little vegetation to resist erosion (USFWS, 2009).

**Stressor:** Nonnative invasive plants (USFWS, 2009)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Nonnative species documented within or adjacent to Eriogonum pelinophilum EOs include: Acroptilon repens (Russian knapweed), Alyssum parviflorum or A. simplex (alyssum), Bromus inermis (smooth brome), Bromus tectorum (cheatgrass), Cardaria draba (whitetop or hoary cress), Cardaria pubescens (hairy whitetop), Ceratocephala testiculata (bur buttercup, hornhead, or curveseed butterwort), Chorispora tenella (blue mustard or crossflower), Cirsium arvense (Canada thistle), Descurainia sp. (tansy mustard), Elaeagnus angustifolia (Russian olive), Erodium cicutarium (storksbill or redstem filaree), Erysimum repandum (spreading wallflower), Halogeton glomeratus (halogeton or saltlover), Lactuca serriola (prickly lettuce), Lepidium perfoliatum (clasping pepperweed), Melilotus officinale (yellow sweetclover), Salsola tragus (prickly Russian thistle), Sisymbrium altissimum (tall tumble mustard), Traxacum officinale (common dandelion) (CNHP 2009, pp. 1-81; USFWS 2009a). Because Eriogonum pelinophilum is a long-lived perennial and was established before many of the nonnatives were introduced, impacts may not be immediate and would require longer term monitoring to quantify. However, nonnatives occur at all EOs (USFWS, 2009).

**Stressor:** Livestock use (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats related to livestock use include the eating of individual plants, physical effects of trampling of plants, and the indirect effects of habitat degradation. During the most extensive survey for the Eriogonum pelinophilum within the most numerous EO (018), minor impacts from livestock, especially from trampling near sheep bed grounds, were documented (Ferguson 2007, p. 2). At one location near sheep bedding grounds, Eriogonum pelinophilum plants were found on root pedestals, apparently due to the increased erosion in the area (Ferguson 2007, p. 8). During 2009, significant livestock impacts occurred within EO 018, the largest Eriogonum pelinophilum site containing over two thirds of the known individuals (USFWS, 2009).

**Stressor:** Herbicide Use (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The proximity of E. pelinophilum to agricultural fields and nonnative species makes the species vulnerable to this impact (USFWS, 2009).

**Stressor:** Herbivory (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Tent caterpillar impacts to E. pelinophilum were noted in 2007 (Ferguson 2007, p. 6). Herbivory where several plants were heavily browsed has been documented in two instances, but the herbivore is unknown and the number of individuals impacted was low (Ferguson 2007, p. 7). Herbivory of numerous individuals was documented associated with livestock use in 2009; although, this use has not yet been well quantified (Sharp, in litt. 2009) (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Future projections for the southwest predict increased temperatures, more intense and longer-lasting heat waves, an increased probability of drought that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). These changes will affect fire frequency, community assemblages, and the ability of nonnative species to succeed. The Mancos shale is limited in distribution and the plant is a long-lived perennial, both factors will limit E. pelinophilum's ability to migrate with a changing climate. Climate change likely is and will affect all Eriogonum pelinophilum populations (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Ten healthy populations are secured in their natural habitat (USFWS, 1988).

Recovery Priority Number: 8C

**Delisting Criteria:**
Twenty healthy populations are secured in their natural habitat (USFWS, 1988).

**Recovery Actions:**
- Initiate scientific research on known and potential habitat and the biology of the species (USFWS, 1988).
- Remove threats to the clay-loving wild-buckwheat and secure populations and tier ecosystems (USFWS ,1988).
- Develop public awareness and appreciation for the "adobes" habitat on which the clay-loving wild-buckwheat grows (USFWS, 1988).
- Permanently protect all occupied habitat. On public lands, add additional and expand existing ACECs, remove threats (especially ORV activity and negative impacts from livestock use), and provide more stringent protection within RMPs. On private land, pursue conservation easements, appropriate zoning incentives, and land acquisitions to protect populations (USFWS, 2009).
- Coordinate with local governments to better protect Eriogonum pelinophilum. Consider lower densities for new developments, open space, avoidance measures, and other actions to conserve the species. Integrate these actions into county and city land use planning designations (USFWS, 2009).
- Conduct education and outreach efforts for the public. The intent of these efforts will be to secure more Eriogonum pelinophilum sites for conservation. Develop and implement permanent conservation agreements and easements for populations on private lands. Provide technical and financial support for conservations actions on private lands (USFWS, 2009).
- Work with all parties to prevent ORV use within Eriogonum pelinophilum habitat (USFWS, 2009).
- Consider removing livestock from all Eriogonum pelinophilum sites. If livestock use continues, careful monitoring of the species and the livestock use should occur. Research (see below) assessing the effects of livestock use should be conducted (USFWS, 2009).

- Conduct nonnative invasive plant control activities where needed to conserve Eriogonum pelinophilum. Control should be conducted with extreme care to reduce impacts to E. pelinophilum (USFWS, 2009).
- Recommend at least a 200 m/656 ft. buffer between occupied or suitable habitat and ground disturbance or other activities that may affect Eriogonum pelinophilum or its habitat (USFWS, 2009).
- Revise the recovery plan for Eriogonum pelinophilum so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats impacting the species. The recovery plan also should estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2009).
- Revise critical habitat for Eriogonum pelinophilum. “Critical habitat” is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (USFWS, 2009).
- Develop and implement consistent conservation measures in the Uncompahgre Field Office’s RMP revision that will avoid and minimize impacts to Eriogonum pelinophilum from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures (USFWS, 2009).
- Expand existing ACECs to include contiguous occupied and suitable habitat for the plant and its pollinators. Revise ACEC management guidelines to better protect Eriogonum pelinophilum. Consider creating new ACECs to conserve the species, especially in the northern portion of the species’ range near the Selig Canal sites (EOs 014 and 025) and unsurveyed land in the area (USFWS, 2009).
- Inventory potential habitat for Eriogonum pelinophilum on public and private lands. Report results to CNHP, BLM, and the Service. These surveys will provide better information to guide recovery and conservation actions as well as project planning (USFWS, 2009).
- Initiate range-wide trend monitoring to track the health of Eriogonum pelinophilum. Include a component to analyze potential effects from disturbances, nonnatives, and climate change (USFWS, 2009).
- Monitor the effects of development activities located within 200 m/656 ft. of plant populations on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2009).
- Conduct demographic monitoring that determines critical life history stages that will enhance management of the species (USFWS, 2009).
- Conduct research studying demographic parameters that identifies critical life history stages (USFWS, 2009).
- Conduct research studying genetic diversity and taxonomic relations of Eriogonum pelinophilum. This research should address what populations are most important to conserve and investigate if genetic diversity is a problem for small isolated populations (USFWS, 2009).
- Conduct research investigating the effects of various threats. For example, impacts of various levels of livestock use, the impacts of ORVs, the impacts of nonnative species, and

the effects of various disturbance levels (USFWS, 2009).

- Incorporate demographic, genetic diversity, and threat research into a population viability analysis that addresses minimum population size, and trajectories factoring in effects of threats (USFWS, 2009).

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# SPECIES ACCOUNT: *Eriogonum tiehmii* (Tiehm's buckwheat)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered

**Physical Description**

Eriogonum tiehmii is a member of the Polygonaceae (buckwheat family). It is a low growing perennial herb forming a dense compact mat up to 10.8 inches (in; 30 centimeters (cm)) across and 6 in (16 cm) high. Leaves are only at the base of the plant, blueish gray in color, elliptic, and gray tomentose, or hairy, on both surfaces. Tight balls of flowers arise from a leafless, hairy stem (i.e. the inflorescence or flowering stalk). The tepals (i.e., components of the flower that are similar looking and cannot be distinguished into sepals and petals) are light yellow to cream, aging lighter and/or turning red with age. Eriogonum tiehmii is the only buckwheat in the subgenus Eucycla known to have well defined stalked glands on the outer surfaces of its tepals (Figure 2; Reveal 1985, pp. 277–278; Morefield 1995, pp. 6–7). (USFWS, 2021)

**Taxonomy**

Eriogonum tiehmii was discovered in 1983 by Arnold Tiehm (Morefield 1995, p. 5) and described by James Reveal in 1985 (pp. 277–278). Within the genus, E. tiehmii is placed in the subgenus Eucycla (Morefield 1995, p 8; Reveal 2012, pp. 256–261). In Nevada, E. tiehmii is morphologically most similar to E. anemophilum (West Humboldt buckwheat) and the creamcolored phase of E. beatleyae (Beatley's buckwheat). However, the stems of the latter are glandular, not hairy as in E. tiehmii, and the involucre (or bracts subtending the flower) of both species are smaller than on E. tiehmii. (USFWS, 2021)

**Current Range**

As described above, Eriogonum tiehmii was first discovered in 1983. As of 1994, E. tiehmii was only known from its type locality, so field surveys were undertaken to relocate the historical location and find any additional locations of the species. Field surveys located five new locations on approximately 9 acres (ac; 3.6 hectares (ha)), all within 1 mile of the type locality (Morefield 1995, p.1). Population boundaries of E. tiehmii were last mapped by Nevada Division of Natural Heritage in 2008–2010, with the most recent surveys for the species conducted in 2019 (Morefield 2008 entire; Morefield 2010, entire; Kuyper 2019, entire). From the 2019 survey effort, the estimated area occupied by the species increased by approximately 14 percent, however, it is unclear if this indicates a true increase in the amount of area occupied by E. tiehmii, because observers and mapping tools used have not been the same among years (Table 1). In 1994, to fully understand the extent of occupied habitat, thirty-three additional sites covering 301 ac (121.8 ha) that met habitat requirements described above were surveyed without encountering Eriogonum tiehmii (Morefield 1995, pp 8–9). Morefield surveyed other areas sporadically between 1995 and 2018 looking for E. tiehmii and had similar results (Ioneer 2020b, p. 12). In 2018, a contractor for Ioneer USA Corporation (Ioneer) developed a habitat suitability model to identify potential habitat for E. tiehmii within a ten-mile radius of the known population utilizing ArcGIS and remote sensing data (Ioneer 2020b, p.12). The habitat suitability model identified 20 sites, totaling 1,126 ac (455.7 ha), as potential habitat based on soil and geology and an additional 24 sites were identified based on professional knowledge of geology, geomorphology, and soils in the surrounding area (Ioneer 2020b, p.12). Surveys of potential habitat by EM Strategies led to the discovery of two additional small subpopulations, subpopulation 7 and 8, near the already known subpopulations. No new populations of E. tiehmii were found within the ten-mile radius of the existing population (Ioneer 2020b, p. 12). (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2021)

**Dependency on Other Individuals or Species**

Adult: Insect pollinated (USFWS, 2021)

**Reproduction Narrative**

Adult: Eriogonum, in general, are sexual reproducers and insects are the most common pollinators (Gucker and Shaw 2019a, pp. 5–6). Some studies have shown that Eriogonum flowers can be pollinated by everything from beeflies and closely related spider predators (the Acroceridea (Cyrtidae)) to specialist pollinators, while other Eriogonum species are capable of selfpollination (Moldenke 1976, pp. 20–25). For example, Eriogonum ovalifolium var. vineum (Cushenbury buckwheat), an endangered buckwheat, is pollinated by flies, as well as sweat bees (Neel and Ellstrand 2003, p. 339). Another endangered buckwheat, E. ovalifolum var. williamsiae (steamboat buckwheat), is self-compatible, but requires a pollinator to transfer pollen from its stamens to its stigma and is visited by a diverse group of bees, wasps, flies, and butterflies (Archibald et al. 2001, p. 612). Primary pollinator visitors to Eriogonum tiehmii include wasps, beetles, and flies (McClinton et al. 2020, p. 18). To test if E. tiehmii is capable of self-pollination, mesh bags were placed over unopened inflorescences to preclude insect visitors in the beginning of the flowering season in May 2020. In early June 2020, additional bags were placed over previously opened, marked flowers that had the opportunity to be visited by pollinators to compare seed production between open-pollinated and bagged flowers (McClinton et al. 2020, p. 22). Results indicate that E. tiehmii plants may be able to produce some seed when pollinators are excluded (through wind pollination or selfing), but open pollination significantly increased seed production, averaging 7.3 times as many seeds as bagged inflorescences (McClinton et al. 2020, p. 22). Therefore, E. tiehmii benefits from pollinator services and needs pollinators to increase seed production. (USFWS, 2021)

**Habitat Type**

Adult: Dry Uplands

**Dependencies on Specific Environmental Elements**

Adult: occurs between 5,906 and 6,234 feet (ft; 1800 and 1900 meters (m)) in elevation (USFWS, 2022)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2022). Inferred due to elevational limitations

**Habitat Narrative**

Adult: Eriogonum tiehmii occurs between 5,906 and 6,234 feet (ft; 1800 and 1900 meters (m)) in elevation and on all aspects with slopes ranging from 0-50 degrees (Ioneer 2020b, p. 5; Morefield 1995, p. 11). The species occurs on dry, upland sites, subject only to occasional saturation by rain and snow and is not found in association with free surface or subsurface waters (Morefield 1995, p. 11). Although there is no information on E. tiehmii's specific water needs during its various life stages (i.e., dormant seed, seedling, juvenile, adult), it appears to be primarily dependent on occasional precipitation for its moisture supply (Morefield 1995, p. 11). From 1980–2017, long-term average annual precipitation during the growing season (October to September) at Dyer, Nevada (the closest climate center to E. tiehmii) was 5.13 in (13.0 cm), with the majority of precipitation received in January and February (Western Regional Climate Center (WRCC) 2020). Thus, we assume that E. tiehmii requires annual precipitation that is at or above the 1980–2017 average. There is also no information on the specific temperature tolerances of E. tiehmii. However, the species experiences warm, dry summers (average daily maximum 85–95°F (29.4–35 °C)) and cold moist winters (average daily minimum 15–25°F (-9.4– -3.9 °C)); WRCC 2020; Morefield 1995, p. 10), which allows us to assume that it adapted to seasonal temperature changes within these ranges. (USFWS, 2021)

***Dispersal/Migration***

**Dispersal**

Adult: Unknown. Likely gravity, wind, and water (USFWS, 2022).

***Population Information and Trends***

**Population Trends:**

Unknown

**Number of Populations:**

1 population, 8 subpopulations ((USFWS, 2021)

**Population Size:**

~43,921 total for all populations (USFWS, 2021)

**Population Narrative:**

Initial surveys for Eriogonum tiehmii documented six subpopulations with an estimated total of 17,015 individuals (Table 1; Morefield 1995, p.14, Appendix 1). The Nevada Natural Heritage Program conducted additional surveys for E. tiehmii from 2008–2010. Again, no new subpopulations were found, but the extent of the six known subpopulations were refined, remapped, and estimated as 36,540 individuals (Table 1; Morefield 2008, entire; Morefield 2010, entire; Kuyper 2019, p.2). A 2019 survey documented eight subpopulations. Two subpopulations were completely surveyed (subpopulations 5, 7) and five subpopulations (subpopulation 1, 2, 3, 4, 6) were sampled with belt transects so that data collection can be repeatable for direct comparisons in the future (Table 1; Kuyper 2019, p. 2; Ioneer 2020b, p. 7). Subpopulation 8 is a single E. tiehmii plant (Kuyper 2019, p. 2). Two additional small subpopulations (7 and 8) were found near the already known subpopulations with the total number of plants estimated as 43,921 individuals. While we have confidence in the 2019 estimates of abundance, the survey methods used are too variable to infer population trends over time. In addition to abundance estimates, the 2019 survey categorized a subsample (1,813 individuals) of Eriogonum tiehmii by size based on plant length and width (Table 2; Kuyper 2019, p. 3; Ioneer 2020b, pp. 7–8). Subpopulation 6 had the most individuals in the smallest size class (seedlings, 0-5 cm2 ) indicating that this subpopulation is likely experiencing the most recruitment (Table 2; Kuyper 2019, p. 3; Ioneer 2020b, pp. 7–8). These data also indicate that overall, most plants in the population are young (5-80 cm2 ), but certain subpopulations —1, 2, and 6 — have the majority of older and larger plants (325-725 cm2 , 725-1260 cm2 , 1260-2000 cm2 , 2000-3000 cm2 , 3000+ cm2 ). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat modification (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This broad category includes threats that can physically disturb, damage, or kill Eriogonum tiehmii plants or degrade or destroy the habitat required by the species. While most of the threats identified here are associated with human activities, some natural processes such as herbivory (causing damage to or killing individual plants) may also impact the species and is discussed in Section 3.1.2. The habitat modification category also includes several threats that increase the potential for invasive, non-native plant species to be introduced into E. tiehmii habitat, thereby increasing competition for resources. While there is evidence of past and on-going habitat modification within the E. tiehmii population, there have been no studies of the species' response to these threats at the individual, subpopulation, and/or population level.

**Stressor:** Herbivory (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory on University of Nevada, Reno (UNR) Seedling Transplant Experiment In 2020, researchers from UNR, under contract with Ioneer, conducted an Eriogonum tiehmii transplant study (see Section 2.4 for further discussion of soil properties related to this study). A total of 3,276 seeds were planted in pots at the UNR greenhouse. Overall, 32 percent emerged (1,057 seeds) and of those, 958 were mature enough (>2 leaves) to be transplanted into the wild on April 27–29, 2020. Three unoccupied sites based on habitat suitability models (see Section 2.5) were chosen for transplanting greenhouse grown E. tiehmii seedlings. Experiment installation and monitoring are described in greater detail in McClinton et al. 2020 (pp. 38–47). After two months of growth in the wild, 62.2 percent (596 plants) of all Eriogonum tiehmii seedlings planted were still present and green. However, monitoring between June 22 and July 6, 2020, detected a major herbivory event in which seedlings were totally excavated or their stems severed, resulting in the loss of almost all transplants (585 plants) (McClinton et al. 2020, p. 43). To gain information about herbivore size, test ways to exclude herbivores, and protect the 1 percent of surviving transplants, different sized exclosures were installed on the remaining plants. These exclosures included hamster cages with bars >2.5 cm apart, open-topped metal cones made of 0.6cm mesh, large fine-meshed metal strainers (20cm diameter), small finemeshed metal strainers (15.9cm diameter), and small fine-meshed plastic strainers (13.3cm diameter) (McClinton et al. 2020, p. 40). All plants left uncovered did not survive. Of the plants

that had an exclosure installed, 59 percent survived until July 21, 2020, which was the last day of monitoring (McClinton et al. 2020, p. 42). Game cameras were installed in July 2020 and deer mice were the most likely culprits of seedling depredation (Service 2020b, entire). Researchers did not expect depredated seedlings to re-sprout (USFWS, 2022)

**Stressor:** Climate Change (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period of time, whether the change is due to natural variability or human activity (IPCC 2014, pp. 119–120). Results of scientific analyses presented by the IPCC show that anthropogenic greenhouse gas emissions have increased since the pre-industrial era as a result of human activities and are now higher than ever. This has led to unprecedented atmospheric concentrations of greenhouse gases and are “extremely likely” (defined by the IPCC as 95–100 percent likelihood) to be the dominant cause of the observed warming since the mid20th century (USFWS, 2022)

***Recovery***

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Eriophyllum latilobum* (San Mateo woolly sunflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/06/1995; Pacific Southwest (R8)

**Physical Description**

An herbaceous (nonwoody) perennial of the aster family (Asteraceae) with leafy stems 30 to 60, exceptionally 90, centimeters (12 to 16 inches) high (J. Mooring, in !itt., 1998). The upper surfaces of the deeply cleft leaves are a smooth dark green and the lower surfaces are covered with densely interwoven white hairs. The golden flower heads are borne in loose clusters (Munz and Keck 1959, McGuire and Morey 1992). Eriophy!lum latilobum differs from Eriophyllum confert~florum (golden yarrow) in having seven to eight ray flowers (the flowers usually located on the edge of the head of members of the aster family) rather than five ray flowers, and a more open inflorescence (Abrams and Ferris 1960, J. Mooring, in litt., 1998). Eriophyllum lanatum var. arachnoideum (common woolly sunflower) differs from the other two species in having 13 ray flowers and shallowly cleft leaves (Abrams and Ferris 1960, Hickman 1993). San Mateo woolly sunflower can be mistaken for plants from several populations that seem to be of hybrid origin between Eriophyllum lanatum and Eriophyllum conferflorum. Plants of these populations have either four or six sets of chromosomes and are located near Black Mountain and Montebello Ridge (Mooring 1994, J. Mooring, in litt., 1996, 1998). (USFWS, 1998)

**Taxonomy**

Eriophyllum latilobum is a tetraploid (having four sets of chromosomes) (Carlquist 1956, Mooring 1973) and is believed to have originated as a hybrid between Eriophyllum confertiflorum var. confertiflorum and Eriophyllum lanatum var. arachnoideum (Constance 1937, Munz and Keck 1959, Hickman 1993, Mooring 1994) (USFWS, 2011). A member of the aster family (Asteraceae) (USFWS, 1998).

**Historical Range**

San Mateo County, California. (USFWS, 2011)

**Current Range**

San Mateo County, California. (USFWS, 2011)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2011)

**Breeding Season**

Adult: April - June (USFWS, 2011)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2012)

**Reproduction Narrative**

Adult: Blooms from April to June. Its pollinators include syrphid flies and bees. Eriophyllum latilobum is not a vigorous reproducer; low germination rates and low seedling survival have been observed under greenhouse conditions (John Mooring, in litt., 1992; McGuire and Morey 1992) (USFWS, 2011).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Cismontane woodland, Gen oak woodland (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 45 - 150 m elevation (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Dependency on Other Individuals or Species for Habitat**

Adult: Quercus agrifolia (USFWS, 2011)

**Habitat Narrative**

Adult: Inhabits moist, steep slopes of serpentine-influenced rocky soil, mostly in shaded spots. Inhabits cismontane woodland (serpentinite, often on roadcuts) at elevations of 45 - 150m (California Native Plant Society 2001) and Gen oak woodland at elevations of 100 - 150m (Hickman 1993). The environmental specificity is very narrow; it is only known from a few sites on serpentine in San Mateo County, California (NatureServe, 2015). Eriophyllum latilobum is restricted to shaded moist sites on steep grassy or sparsely wooded slopes. It apparently grows best under or very near coast live oak (Quercus agrifolia) (J. Mooring, in litt., 1998) (USFWS, 2011).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2012)

**Dispersal/Migration Narrative**

Adult: Seed dispersal is by gravity, so most seeds fall close to the parent plant (J. Mooring, pers. comm. as cited in McGuire and Morey 1992) (USFWS, 2011).

***Population Information and Trends***

**Population Trends:**

Decline of 30-50% (NatureServe, 2015)

**Species Trends:**
Additional occurrences discovered since listing (inferred from USFWS, 2011)

**Number of Populations:**
4 (USFWS, 2011)

**Population Size:**
250 - 1000 individuals (NatureServe, 2015); variable from year to year (USFWS, 2011)

**Adaptability:**
Low (inferred from NatureServe, 2015)

**Population Narrative:**
Apparently highly vulnerable though the exact biological reasons are unknown. This species has experienced a long-term decline of 30-50%. The main population near Crystal Springs, San Mateo County, has declined from many plants to a few hundred after an unfortunate mowing incident in 2001 (?). However there were about 200 seen in the latest survey. An additional 200 seen at Montara Mtn site in 2004. 3 and possibly a couple more sites known. Only two are currently mapped at CNDDB; backlog contains a few more. 1 from La Honda is historical. The estimated population size is 250 - 1,000 plants (NatureServe, 2015). Some years the number of plants in some subpopulations ranges from zero to less than five; other years the same subpopulations contain 500 percent more plants. At the time of listing, there was only one known population on Crystal Springs Road. Since then, there have been three additional occurrences discovered (USFWS, 2011).

***Threats and Stressors***

**Stressor:** Habitat degradation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The steep slopes along Crystal Springs Road provide a very unstable habitat for E. latilobum. The slopes are subject to erosion and soil slippage. After soil slippage occurs, road maintenance crews remove the slumped soil, which may contain mature individuals, seedlings, and/or seeds of E. latilobum. The road cut is then reshaped, which may damage plants remaining on the banks. Dumping of garden debris and downhill seepage of pesticides from homeowners living above the population may have negative impacts on Eriophyllum latilobum habitat (USFWS, 2011).

**Stressor:** Nonnative vegetation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The plant is threatened by competition with nonnative plants; its habitat is more densely populated with Carduus sp. and Bromus sp. than it was 10 years ago (John Mooring, pers. comm., 1992). In a 2009 report prepared by Nomad Ecology for San Francisco Public

Utilities Commission and M&E/WRE Joint Venture, the non-native invasive plants considered a threat to habitat along Crystal Springs Road included fennel, French broom, and jubata grass. Other non-native invasive plants teasel, poison hemlock, bull thistle, and milk thistle were also present in this area (Nomad 2009). In the natural population, competing species such as plumeless thistle (Carduus sp.) may affect germination and seedling establishment (J. Mooring, in litt., 1998). (USFWS, 2011)

**Stressor:** Low reproductive output (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Germination rates for E. latilobum are lower than for any other sunflower, less than 10% (CDFG 1997). In the 2009 seed bank collection report from Rancho Santa Ana Botanic Garden, seed collected from CNDDB #4 had a germination rate of 28% (USFWS, 2011).

**Stressor:** Stochastic events (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The small number of populations and low numbers of individual plants are also a factor. Because of the existence of few populations exhibiting low viability and located in an unstable habitat, this species is extremely vulnerable to extinction from random catastrophic events (Menges 1991, Primack 1993, Meffe and Carroll 1994) (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, Eriophyllum latilobum plants would likely be unable to shift their range because of their dependence on a rare soil type and their supposed limited ability for seed dispersal (USFWS, 2011).

***Recovery***

**Reclassification Criteria:**
A/1: A minimum of five colonies1 of San Mateo woolly sunflower are fully protected and managed with the primary intention of preserving the occurrences in perpetuity. Each protected colony includes occupied habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer at the known site. If genetic research confirms that additional historical and/or extant Eriophyllum populations in San Mateo County were/are San Mateo woolly sunflower, these sites are also protected and managed as described above. If additional individuals, sub-populations, or populations are discovered on private lands, they are secured through land

acquisitions, conservation easements, or other means and protected as described above. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the colonies described in A/1 and any occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized annual monitoring of populations and provisions for the collection and preservation of viable genetic material that might otherwise be lost because of planned habitat destruction or modification. (USFWS, 2019)

E/1: Each colony described in A/1 contains a minimum of 150 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

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

E/3: Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 5 years in order to ensure seed viability. (USFWS, 2019)

E/5: If genetic research confirms that CNDDB occurrences #2 and #3 contained populations of San Mateo woolly sunflower that have since been extirpated, these occurrences are reestablished using appropriate habitat restoration and plant propagation techniques. These additional occurrences are important due to the limited availability of the appropriate habitat. (USFWS, 2019)

Recovery Priority Number: 11

**Delisting Criteria:**
A/1: A minimum of 20 self-sustaining colonies of San Mateo woolly sunflower are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. If historical and/or extant Eriophyllum colonies (outside of the San Mateo Creek Watershed) are determined to be San Mateo woolly sunflower, a minimum of 40 self-sustaining colonies are protected and managed as described above. Additional colonies are protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the colonies described in A/1 are protected from incompatible uses.

A/3: Potential negative effects to San Mateo woolly sunflower habitat from sudden oak death infestations are absent or below a level that threatens colony health and/or persistence.

(USFWS, 2019)

E/1: For a minimum of 20 consecutive years that include two normal precipitation cycles each colony described in A/1 exhibits a stable or increasing population trend with a rolling average of at least 300 individuals. During low density years (presumably from natural population fluctuations), each colony described in A/1 contains a minimum of 150 individuals. (USFWS, 2019)

E/4: Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in A/1. (USFWS, 2019)

E/5: Long-term management of San Mateo woolly sunflower habitat is both practically and financially sustainable. Financial resources for long-term habitat management are secured. (USFWS, 2019)

**Recovery Actions:**

- 1. Protect San Mateo woolly sunflower colonies and identify or establish additional colonies. 1.1. Ensure that all road and utility maintenance personnel are aware of San Mateo woolly sunflower along Crystal Springs Road and mark colonies with permanent signs/markers. Implement other protection measures as needed. (Priority 1). 1.2. Secure colonies through land acquisitions, conservation easements, or other means. (Priority 1). 1.3. Identify and protect potential introduction sites. (Priority 1). 1.4. Search for additional colonies on private and city land. Secure additional colonies through land acquisitions, conservation easements, or other means. (Priority 2). 1.5. Implement a seed increase and/or propagation program that may be used to establish new colonies and supplement existing colonies when necessary. (Priority 2). 1.6. Establish new colonies, to the extent described in the recovery criteria, within or near the species' known historical range. Colonies should be established in suitable habitats that exhibit a range of natural environmental conditions. Numerous introductions may be necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 2). (USFWS, 2019)
- 2. Research San Mateo woolly sunflower life history and conservation strategies. 2.1. Conduct genetic research on existing colonies to determine the species' genetic structure and genetic diversity. (Priority 1). 2.2. Study the historical and extant Eriophyllum occurrences that have been classified as San Mateo woolly sunflower to determine accurate species identities. Delineate the actual and historical range of San Mateo woolly sunflower. (Priority 1). 2.3. Research and develop reliable seed germination and propagation techniques. (Priority 1). 2.4. Determine the most effective and efficient habitat management practices to enhance colony health and reduce impacts from competing species and erosion. Experimentally test fire disturbance104 as a management tool. (Priority 1). 2.5. Research optimal habitat characteristics, factors influencing seed germination, mechanisms of dispersal, impacts of seed predation, and potential impacts from climate change. (Priority 2). 2.6. Study the demography (including seedling survivorship). , reproductive biology, and phenotypic plasticity (the capacity for marked variation in observable structural and functional properties of an organism because of environmental influences during development). of colonies. (Priority 3). (USFWS, 2019)

- 3. Monitor and manage San Mateo woolly sunflower colonies. 3.1. Implement site-specific management plans. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). . Best habitat management and restoration practices may include complete eradication of nonnative species, planting coast live oak trees, and/or treating sudden oak death infestations. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 5 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2011 5-year review, 2019 Recovery Plan Amendment (Service 2019), scientific literature, and as a result of discussions with species experts. 1. Protect San Mateo woolly sunflower colonies and identify or establish additional colonies. Ensure that all road and utility maintenance personnel are aware of San Mateo woolly sunflower along Crystal Springs Road. 2. Monitor and manage San Mateo woolly sunflower colonies. Conduct regular protocol surveys and implement site-specific management plans. Establish an encroachment threshold for invasive plants that triggers management action. 3. Research San Mateo woolly sunflower life history and increase understanding of its germination and propagation to determine the potential for reintroduction success. (USFWS, 2021)

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# SPECIES ACCOUNT: *Eryngium aristulatum var. parishii* (San Diego button-celery)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 08/03/1993; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A perennial or biennial herb arising from a taproot. The flowers occur on stems and have rigid spiny bracts (NatureServe, 2015).

**Taxonomy**

A member of the Apiaceae (parsley/carrot family). Eryngium aristulatum var. parishii is one of three varieties of Eryngium aristulatum (Constance 1993, p. 147). Eryngium aristulatum var. parishii is separated from Eryngium aristulatum var. aristulatum (common) by having styles in fruit that are about the same length as the calyx (outer whorl of protective structures around the flower) and is separated from Eryngium aristulatum var. hooveri (Hoover's button-celery) by having bractlets (modified leaves) without callused margins (Constance 1993, pp. 147–148) (USFWS, 2010).

**Historical Range**

At the time of listing, Eryngium aristulatum var. parishii was considered extant in Riverside County at Santa Rosa Plateau, in San Diego County at Otay Mesa, Kearny Mesa, Del Mar Mesa, Marine Corps Air Station (MCAS) Miramar, and Marine Corps Base (MCB) Camp Pendleton, and in northern Baja California, Mexico (USFWS 1993, p. 41385). The historical distribution of Eryngium aristulatum var. parishii habitat included a coastal swath from Mesa de Colonet and San Quintin in Baja California, Mexico, north to Los Angeles County, California in the United States (USFWS, 2010).

**Current Range**

Eryngium aristulatum var. parishii currently occurs in 14 geographic areas in Riverside and San Diego Counties (USFWS, 2010). Occurs in the Santa Rosa Plateau in Riverside Co. and San Diego Co. California, and Baja California, Mexico. This species occurs in a small portion of the southwest portion of Riverside Co., and from San Diego Co. from Camp Pendelton Marine Base south into Baja California, Mexico to Ensenada (USFWS 1998) (NatureServe, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2010)

**Lifespan**

Adult: 2+ years (inferred from USFWS, 2010)

**Breeding Season**
Adult: April - June (USFWS, 2010)

**Key Resources Needed for Breeding**
Adult: Ephemerally wet conditions; insect pollinators, based on closely related species (USFWS, 2010)

**Reproduction Narrative**
Adult: Relies on ephemerally wet conditions to reproduce; blooming from April to June. It is an outcrossing taxon that reproduces exclusively by seeds. E. a. var. parishii is presumably insect-pollinated (Zedler 1987, pp. 61–64), potentially by bee flies (Bombyliids) (Schiller et al. 2000, pp. 386–396) and solitary bees (Apoidea), as are many vernal pool species (Thorpe 2007, pp. 51–57) (USFWS, 2010).

**Habitat Type**
Adult: Wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**
Adult: Vernal pool (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**
Adult: Disturbance regime (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**
Adult: Succession (inferred from USFWS, 2010)

**Environmental Specificity**
Adult: Very narrow (inferred from USFWS, 2010)

**Tolerance Ranges/Thresholds**
Adult: Moderate (inferred from USFWS, 2010)

**Habitat Narrative**
Adult: Grows in vernal pools (Smith and Berg, 1988) (NatureServe, 2015). It is a clay soil, surface and non-surface hard pan, vernal pool obligate. Eryngium aristulatum var. parishii seems more tolerant of peripheral vernal pool habitat than most obligate vernal pool species. It is specifically adapted to surviving in vernally wet conditions due to the presence of aerenchyma tissue (air channels in the roots) that facilitates necessary gas exchange in submerged plants (Keeley 1998, pp. 121–175). Habitat occupied by Eryngium aristulatum var. parishii is dependent upon some form of disturbance to set back succession (e.g., periodic fire and annual inundation) (USFWS, 2010).

***Dispersal/Migration***

**Dispersal/Migration Narrative**
Adult: Not available

***Population Information and Trends***

**Population Trends:**

95 - 97% decline in habitat (USFWS, 2010)

**Number of Populations:**

~98 U.S. locations presumed extant or extant (USFWS, 2023)

**Population Narrative:**

It is restricted to southern coastal California, with few occurrences in northern Baja California, Mexico. Eryngium aristulatum var. parishii can be locally abundant in remnant vernal pools; however, the distribution of this variety has been dramatically reduced due to loss of most (95 to 97 percent) of the vernal pool habitat in San Diego County (USFWS 1998, p. iii) (USFWS, 2010). In summary, the species is extant or presumed extant at approximately 98 locations within the Unites States. At least 26 locations in the United States are considered extirpated or possibly extirpated. There are likely many more extirpated locations that were not recorded prior to development, because by 1978, 90 percent of vernal pool habitat in San Diego County was already lost (Beauchamp 1979, p. 1). The isolated populations newly documented in Orange County and 100 miles farther south in Baja California, Mexico, appear to be outliers, and the core distribution in Riverside and San Diego counties remains mostly unchanged. Therefore, this information does not substantially alter our understanding of the distribution of Eryngium parishii var. aristulatum (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Urbanization and agricultural development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss of habitat from development is considered a primary contributor to vernal pool loss throughout California (Holland 1988, p. 1013; Barbour et al. 2007, p. 7), and specifically to vernal pools in southern California (Bauder 1986, p. 9-4; Bauder 1987, pp. 209–213). There is no certainty nor is there any likelihood that pools or pool complexes that fall outside the Multiple Habitat Planning Area (MHPA) will ultimately be conserved; these areas are still subject to development pressures. What was once a large, relatively unbroken expanse of patchy but interconnected pool habitat, has become remnant “islands” of vernal pools within an expanse of varying levels of anthropogenic disturbance, and permanently altered landscape (e.g., pools at N 8 General Dynamics site on Kerney Mesa, I 6C Bob Baker 2 on Mira Mesa, and C17– 18 on Mira Mesa; see Appendix 1) (USFWS, 2010).

**Stressor:** Off-highway vehicle (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Damage can be caused by motorcycles, quads, mountain bicycles, and four-wheel drive vehicles. Bauder (1987, p. 209) indicated that some impacts from OHVs were considered vandalism, while other damage occurred in the course of legitimate activities including fire

fighting, security patrols, and military maneuvers. Altered pool hydrology may favor invasion of nonnative plants by allowing nonnatives to encroach in areas where the hydrological conditions had been altered by OHVs; vehicles can also break through the clay hard pan, causing hydrological damage that may not be repaired. The use of OHVs causes fragmentation, degradation, and destruction of vernal pools (Hilty et al. 2006, p. 157; Forman et al. 2003, pp. 113–138; Wilcove et al. 1998, pp. 607–615). Transportation corridors have the potential to spread disease, drain or damage pools, and facilitate the invasion of nonnative species (Hilty et al. 2006, p. 157) as well as mixing of otherwise naturally separated native species and genotypes (e.g., fairy shrimp lineages). It is likely that OHV use continues to be a nearly rangewide threat to Eryngium aristulatum var. parishii and its habitat (USFWS, 2010).

**Stressor:** Trampling (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat destruction associated with livestock and human access was considered to be a threat to Eryngium aristulatum var. parishii at listing (USFWS 1993, p. 41388) and in the Recovery Plan (USFWS 1998, p. 47). Impacts from this threat include soil compaction and erosion, though this is not a predominant threat. Destruction of E. a. var. parishii habitat from cattle is dramatically reduced, though some vernal pools continue to be impacted by livestock, such as horses in the J26 vernal pool complex in Otay Mesa (Wynn, pers. comm. 2010) (USFWS, 2010).

**Stressor:** Mowing and plowing (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mowing and plowing/discing of habitat has been used to reduce fire hazards and to shorten vegetative cover for birds to reduce bird air-strike hazards and bird air mortality hazards (U.S. Marine Corps 2006, pp. 7-1–7-36; U.S. Marine Corps 2007, pp. F-47–F-49). Restrictions of these activities where there is a Federal or State nexus via INRMP site management plans and overarching MSHCPs have reduced the loss of habitat due to mowing or plowing; however, impacts from this threat have yet to be quantified (USFWS, 2010).

**Stressor:** Highway construction (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road development and inter-related actions were classified as a threat to Eryngium aristulatum var. parishii when it was listed. Roads are closely associated to habitat fragmentation (loss) due to urban and agricultural development. Vernal pools and associated habitat proximal to basins have been eliminated by road and highway construction. Mitigation for roadway development has included the restoration of vernal pool habitat and introduction of key vernal pool species. Restoration of vernal pools has had some degree of success in the short term; however, the long term effectiveness of this mitigation approach is still being studied (Black and Zedler 1998, pp. 195–205). Road development and related construction activities are still a primary threat to the variety (USFWS, 2010).

**Stressor:** Altered hydrology (USFWS, 2010)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Seasonality (phenology) of vernal pools requires annual hydrologic input during the spring months to moisten and fill pools and basins. Due to urbanization, hydrologic cycles have been affected near vernal pool complexes (Bauder 1987, pp. 209–213). However, impacts from this threat to Eryngium aristulatum var. parishii appear to have decreased since the time of listing due to development standards that are intended to prevent runoff from entering vernal pool basins (Wynn, pers. obs. 2009) (USFWS, 2010).

**Stressor:** Military activities (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts to vernal pool sites resulted from large equipment (e.g., tanks) and civilian use on base (USFWS 1993 p. 41388). Training activities near and adjacent to vernal pool habitat have resulted in site-specific impacts to vernal pool species, such as rutting of pools. Approximately 70 percent of the remaining vernal pool complexes occur on lands within military jurisdiction (USFWS 2008, p. 16). Since listing, conservation efforts on military lands have been in place due to implementation of the Sikes Act and the Sikes Act Improvement Act described below under Factor D, which require military installations to develop INRMPs (USFWS, 2010).

**Stressor:** Insect herbivory (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Predation was not identified as a threat at listing, but insect herbivory of E. a. var. parishii was later considered a disturbance concern in the recovery plan and remains a potential threat to the taxon (USFWS 1993, p. 41388; USFWS 1998, p. 67). This can have considerable effects on plant population dynamics, and may include: (1) Damage to roots, leaves, flowers, and developing seeds; and (2) ultimately reduce living plant fitness and reproductive success in the presence of native and nonnative competitors (Louda 1994, pp. 118–138) (USFWS, 2010).

**Stressor:** Nonnative plants (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** San Diego County and the range of Eryngium aristulatum var. parishii are in a mild, Mediterranean climate zone that makes the potential and rate for nonnative species incursion high. Nonnative plants are documented to alter natural landscapes and available habitat in San Diego County (Bauder 1987, pp. 209–213). Invasive, nonnative plants have long been considered a concern in vernal pool habitat (Holland 1988, p. 1014). Some of these biological impacts include competition with E. a. var. parishii for water, soil nutrients, space above and below ground, and displacement of natural pollinators. Bauder (2005, p. 2133) states that Agrostis avenaca (Pacific bentgrass) and Polypogon monspeliensis (rabbitsfoot grass) are present in San Diego County vernal pools, and that research in the field and under controlled conditions indicates “both grasses negatively affect native pool species in a variety of ways, ranging from survivorship to reproductive success.” (USFWS, 2010).

**Stressor:** Altered fire regime (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is a natural component for regeneration and maintenance in E. a. var. parishii habitat (Bauder 1996, p. 2). However, the taxon faces two seemingly diametrically opposed forces: lack of fire, and re-introduction of fire (accidental and purposeful) to an altered landscape. Fire in areas where Eryngium aristulatum var. parishii exist can remove vegetation cover that would otherwise aid in controlling erosion post fire. This may in turn result in local sedimentation of the pools or otherwise disrupt vernal pool ecology. Although habitat occupied by Eryngium aristulatum var. parishii is dependent upon some form of disturbance to set back succession (e.g., periodic fire and annual inundation), fires at critical times can eliminate populations of E. a. var. parishii by killing individual plants or seed banks through intense heat, or overheating soil to create hydrophobic conditions (Agee 1993, pp. 1– 493; Keane et al. 2002, pp. 3–11; Keeley 2001, pp. 81–94; Arno and Fiedler 2005, pp. 7–38) (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Eryngium aristulatum var. parishii is limited by its inherent ecological tolerances and by past and current anthropogenic activities that occur within a vernal pool, in proximity to vernal pool complexes, or within a watershed of a vernal pool or complex. Events outside the range of natural influence or frequency variability, such as floods, fires, contamination, or drought, can substantially reduce or eliminate small populations and increase the likelihood of extinction (Lande 1993, p. 912). Small populations are more vulnerable to natural catastrophes and stochastic demographic, genetic, and environmental events (Barrett and Kohn 1991, pp. 3–30). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61) (USFWS, 2010).

**Stressor:** Loss of pollinators (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Cumulative effects of habitat loss, drought, and urbanization on native pollinators contribute to an extant and future threat to Eryngium aristulatum var. parishii. The National Research Council of the National Academies (2007, pp. 73–74) indicated that “some pollinators in North America representing a diversity of taxa are, in fact, in decline.” When native pollinators are diminished, redundancies in pollinator systems may be disrupted thus impacting the reproductive output of the variety (USFWS, 2010).

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drought was noted as a threat to Eryngium aristulatum var. parishii at the time of listing; however, its relationship to climate change has been derived since listing. The effects of

an unpredictable precipitation regime on vernal pools, and on vernal pool species will have consequential effects on short and long term persistence of most if not all pools within basins (Bauder 2005, pp. 2129–2135). Ecosystem communities in California are expected to be ‘reshuffled’ due to climate disruption (Stralberg et al. 2009, pp. 1–8). The Service recognizes that climate change is an important issue with potential effects to listed species and their habitats; however, information to make precise oceanographic and atmospheric predictions regarding its immediate effects to vernal pool species, including Eryngium aristulatum var. parishii and its habitat, is lacking (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
1. Existing vernal pools and their associated watersheds that contain Eryngium aristulatum var. parishii should be secured from further loss and degradation in a configuration that maintains habitat functions and species viability (USFWS, 1998).

2. The existing vernal pools and their associated watersheds contained within the complexes identified in Table 5 are secured in a configuration that maintains habitat function and species viability (as determined by recommended research) (USFWS, 1998).

3. Secured vernal pools are enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 1998).

4. Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. Monitoring should continue for a period of at least 10 years following reclassification to ensure population stability (USFWS, 1998).

Recovery Priority Number: 9C (USFWS, 2023)

**Delisting Criteria:**
Delisting of the species is conditional on the downlisting criteria shown above, improvement (stabilized or increasing population trends) at all currently known sites; restoration, protection, and management of the minimum habitat area and configuration needed to ensure long-term viability; and establishing historic but locally extirpated species populations when needed to ensure viability (USFWS, 1998).

In the interest of ensuring these criteria are clearly articulated, we are amending the following clarification to the existing recovery plan. This amendment does not represent a revision of the delisting criteria, it simply provides more specific terminology. Delisting for the species covered by the 1998 recovery plan may be considered when the downlisting criteria have been met and: 1. All 74 geographic areas and associated vernal pool complexes as identified in Appendices F and G of the 1998 Recovery Plan under each of the specific management areas are protected and managed to ensure long-term viability. 2. The U.S. Fish and Wildlife Service must determine that the following factors are no longer present, or continue to adversely affect, Eryngium aristulatum var. parishii, Pogogyne abramsii, Pogogyne nudiuscula, Orcuttia californica, and the Riverside and San Diego fairy shrimp: ( 1) the present or threatened destruction, modification, or curtailment of their habitat range; (2) over utilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and ( 5) other natural and manmade factors affecting their continued existence (50 CFR 424.11). 3. Population trends for all seven taxa continue to be stable or increasing for 10 consecutive years after threats have been sufficiently ameliorated or managed ( completion of delisting criterion 2) prior to consideration for delisting. (USFWS, 2019)

**Recovery Actions:**

- Conduct surveys and research essential to the conservation of the species (USFWS, 1998).
- Secure the existing vernal pools and their associated watersheds (USFWS, 1998).
- Where necessary reestablish vernal pool habitat to the historical structure (USFWS, 1998).
- Manage and monitor habitat and listed species (USFWS, 1998).
- Conduct rangewide monitoring using species-specific protocol to ascertain distribution and abundance; assimilate monitoring data into a standardized database available to all cooperators, researchers, public, and regulators. Publish results in peer reviewed journal(s) (USFWS, 2010).
- Develop a coordinated interagency invasive species prevention and eradication program for all vernal pool habitat where Eryngium aristulatum var. parishii is extant (USFWS, 2010).
- Identify Eryngium aristulatum var. parishii pollinators, their required habitat, and implement measures to ensure their maintenance throughout the range of E. a. var. parishii (USFWS, 2010).
- Conduct hydrological monitoring and modeling to ascertain vulnerability of pools and complexes to likely altered hydrological conditions associated with climate change (USFWS, 2010).
- Determine the utility of enhanced and artificially created vernal pools to the conservation of the species and standardize methods of site selection, selection of propagation materials, outplanting protocols, success criteria, and remediation methods (USFWS, 2010).
- Coordinate with partners, such as MCAS Miramar and MCB Camp Pendleton, to help manage and protect vernal pool habitat (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The actions are intended to reduce threats to Eryngium aristulatum var. parishii and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of E. a. var. parishii will require cooperation and coordination with partners to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. 1. Work with partners to identify opportunities for conservation of Eryngium aristulatum var. parishii occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire E. a. var. parishii habitat. 2. Adaptively manage E. a. var. parishii occurrences to maintain, enhance, or restore habitat and reduce threats. a. Manage nonnative species in vernal pool habitat. b. Coordinate with partners to develop a nonnative species prevention and eradication program for all vernal pool habitat where E. a. var. parishii is extant. c. Ensure the correct species pallet from a nearby source is being selected for areas during restoration projects inside and outside of the known range for E. a. var. parishii. 3. Monitor occurrences to assess management effectiveness. a. Conserve E. a. var. parishii seed in an off-site seed bank. b. Work with partners in Baja California, Mexico to survey additional areas for E. a. var. parishii and identify conservation opportunities. 4. Maintain or enhance E. a. var. parishii genetic diversity. a. Conduct a population genetics study to characterize genetic variation and structure. Based on study results, develop best management practices to maintain genetic diversity within the species. b. Further investigate the taxonomy and genetic relationships between of E. aristulatum, E. vaseyi, E. aristulatum var. hooveri, E. pendletonense, and other similar Eryngium species; especially those occurring at MCB Camp Pendleton, Costa Mesa, Santa Rosa Plateau, and Baja California, Mexico, and compare to E. a. var. parishii. c. Investigate/monitor the potential for hybridization between E. a. var. parishii and E. pendletonense at Bluff Las Flores [EO 53]. 5. Model species' response to climate change and assess options to translocate the species into projected suitable habitat. a. Develop hydrological monitoring and modeling to determine characteristics and identification of pools and complexes likely to be impacted by prolonged drought, and lack of seasonal rainfall caused by climate change effects to El Niño/Southern Oscillation (USFWS, 2023).

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# SPECIES ACCOUNT: *Eryngium constancei* (Loch Lomond coyote thistle)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 08/01/1985; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

Loch Lomond button-celery is a perennial herb. Decumbent. Several flowered inflorescence with spiny bracts (NatureServe, 2015).

**Taxonomy**

Problematic genus, but E. constancei seems generally agreed upon as an entity (Bittman 1998) (NatureServe, 2015). A member of the carrot family (Apiaceae). Other common names for this species are Loch Lomond button-celery and Constance's coyote-thistle (Smith et al. 1980) (USFWS, 2005).

**Historical Range**

For over 5 decades, this species was known only from Loch Lomond, where it was first collected in 1941 (Sheikh 1983). Eryngium constancei has always been restricted to the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998) (USFWS, 2005).

**Current Range**

At the time of listing, the Loch Lomond coyote-thistle was only known to occur within the bed of a 7-acre vernal lake near the mountain community of Loch Lomond in southern Lake County, California (Service 1986, p. 45904). In our previous 5-year review, we described four known occurrences: three in Lake County and one in Sonoma County (Service 2009, p. 10). These occurrences, from north to south include the Dry Lake occurrence south of Clear Lake, the occurrence near Loch Lomond, an occurrence near the town of Cobb, and the Diamond Mountain occurrence near the city of Calistoga in Sonoma County (Service 2009, p. 10). In 2013, a comment reported to the Diversity Database suggested the population in Sonoma County may actually be a pubescent form of Eryngium aristulatum; however, an unpublished occurrence report submitted to the Diversity Database in 2021 confirms the species identification (Diversity Database 2021 unpublished report, p. 1). The current distribution of the Loch Lomond coyotethistle is the same as described in the 2009 5-year review, with all populations currently presumed extant (USFWS, 2023).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 2+ years (USFWS, 2005)

**Breeding Season**

Adult: June - August (USFWS, 2005)

**Reproduction Narrative**

Adult: Eryngium species are biennial or perennial, with an overwintering rootstock. Eryngium constancei flowers after the water evaporates from the pools, typically between June and August (California Department of Fish and Game 1985, 1994) (USFWS, 2005).

**Habitat Type**

Adult: Terrestrial, wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Northern volcanic ashflow vernal pool, Northern basalt flow vernal pools (USFWS, 2009)

**Geographic or Habitat Restraints or Barriers**

Adult: ~463 - 853 m elevation (NatureServe, 2015; USFWS, 2009)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Eryngium constancei grows abundantly within the borders of the meadow-like bed of the Loch Lomond lake at an elevation of 853 m. Rain fills the lake bed in winter, but the water evaporates in spring and early summer, leaving a seasonal meadow-like area in which Eryngium constancei and other plants germinate, flower, and set seed. The volcanic soils of the lake basin, together with its particular hydrological characteristics and the surrounding topography, may account for the unique presence of this species. It lives in fragile vernal pool habitat. The environmental specificity is very narrow (NatureServe, 2015). Loch Lomond is a small, intermittent lake with a surface area of about 3.2 hectares (7 acres) at maximum inundation (U.S. Fish and Wildlife Service 1985). This wetland is classified as a Northern Volcanic Ashflow Vernal Pool (Sawyer and Keeler-Wolf 1995; CNDDB 2007) and is on Collayomi-Aiken-Whispering complex soils. The surrounding area is mountainous and supports a mixed forest. On Diamond Mountain, the pools where Eryngium constancei grows are shallow and spring-fed (CNDDB 2007); they are classified as Northern Basalt Flow Vernal Pools (Sawyer and Keeler-Wolf 1995; CNDDB 2007). The Dry Lake pool is at an elevation of 463 meters (1,520 feet) and is surrounded by Quercus douglasii (blue oak) woodland. (USFWS, 2009). Soils underlying Dry Lake are in the Sobrante-Guenoc-Hambright complex (USFWS, 2005).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Unknown; presumed decline of < 30% (NatureServe, 2015)

**Species Trends:**

3 additional occurrences found since listing (USFWS, 2009); stable (NatureServe, 2015)

**Number of Populations:**

3 (USFWS, 2023)

**Population Size:**

Millions (total) (USFWS, 2023)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Additional Population-level Information:**

At the time of listing, abundance estimates were not available for the one population at Loch Lomond, but it was described as abundant (Service 1986, p. 45904). The previous 5-year review reported population abundances of millions for the Loch Lomond population, 50,000 for the Diamond Mountain population, and 25,000 for the Dry Lake population. However, these estimates were from 1991, 1996, and 1997, respectively. There was no abundance estimate reported for the Cobb population (Service 2009, p. 9). Current abundances are similar to what was reported in the previous 5-year review (Diversity Database 2023); however, the unpublished report submitted to the Diversity Database in 2021 reported the Diamond Mountain population had declined to approximately 20,000 plants (Diversity Database 2021 unpublished report, p. 1). As described in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (Recovery Plan) (Service 2005), which includes the Loch Lomond coyote-thistle, we would not expect the population to vary substantially among years because the species is a perennial (USFWS, 2023).

**Population Narrative:**

This vernal pool plant is vulnerable, though the biological reasons for it are unknown. The long term trend is not known, but is assumed to have been a slight decline (< 30%). The estimated population size is millions of individuals each year (Bittman 1998). The population trend has been stable for the past 10 years (NatureServe, 2015). Since listing in 1986 and proposed downlisting in 1993, three additional occurrences of Eryngium constancei were found. There are four extant occurrences (USFWS, 2009). The Dry Lake and Sonoma County populations numbered in the tens of thousands in both 1996 and 1997. However, in 1996, the Loch Lomond population was at least two orders of magnitude larger than in 1997 (California Natural Diversity Data Base 2003). The size of the fourth population has not been reported (USFWS, 2005).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, routine highway maintenance, trash dumping and, to a smaller degree, occasional fence vandalism, vehicle trespass, and trampling still threaten E. constancei at the Loch Lomond site. Specific threats to two of the four extant populations are that at least one of the occupied pools at Diamond Mountain may be converted to a vineyard, and the owner of Dry Lake has proposed excavating the pool for a reservoir (CNDDB 2007). Changes in hydrology threaten three of the four occurrences. In addition, runoff from adjacent roads and swimming pools creates excess water flow, whereas drainage ditches, culverts, and diversion of a natural spring are reducing the flow of water to E. constancei habitat (Hrusa and Buckmann 2000; CNDDB 2007). Existing and potential sources of changes to the hydrology at two sites include

adjacent roads, drainage ditches in and adjacent to Loch Lomond, development south of the lake (CNDDB 2007), and a culvert alongside one of the Diamond Mountain pools. Larger-scale hydrological alterations, including commercial development and timber harvesting, are also occurring in all the watersheds where Eryngium constancei grows, thus posing added hydrological threats (U.S. Fish and Wildlife Service 1986, 1993; CDFG 1994; K. Aasen in litt. 1995; B. Hunter in litt. 1996; CNDDB 2007). Not only does removal of trees and construction of logging roads alter the flow of water, but it also causes erosion, which can bury the plants and affect the hydrology (U.S. Fish and Wildlife Service 1985, U.S. Fish and Wildlife Service 1986, U.S. Fish and Wildlife Service 1993; California Department of Fish and Game 1994; Aasen in litt. 1995; B. Hunter in litt. 1996). The Loch Lomond and Diamond Mountain occurrences are threatened by hydrological alterations within their watersheds. By affecting the amount of runoff entering the pools or the rate at which the pools dry, the depth and duration of inundation can increase or decrease, creating conditions unsuitable for the survival of Loch Lomond coyote thistle. The Dry Lake occurrence is threatened by trash dumping and erosion into the pool; the surrounding slopes have been stripped of vegetation and are eroding (CNDDB 2007). The Loch Lomond occurrence is also threatened by occasional fence vandalism and vehicle trespass (S. Zalusky, pers. comm. 2008) (USFWS, 2009).

**Stressor:** Trampling/grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, the occurrence at Dry Lake is heavily impacted by horse padocking (S. Zalusky, pers. comm. 2008) (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The extremely restricted distribution of Eryngium constancei is a threat to its long-term viability. Although the individual populations are sufficiently large that intrinsic problems such as genetic drift are not a concern, other random events could cause the species to go extinct. Catastrophic weather events, climate change, or other unforeseen circumstances potentially could eliminate all of the populations. In particular, small numbers of localities makes it difficult for this species to persist while sustaining the impacts from adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events or additional environmental disturbance (Goodman 1987; Gilpin and Soule 1988). If a locality of E. constancei has several consecutive years of poor rainfall, or changes in hydrology from adjacent development, it is possible that all individuals within the locality will become extirpated (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drought or flood conditions will place additional strains on the vernal pool ecosystem supporting E. constancei occurrences, some of which are already fragmented or reduced by habitat conversion to wineries and development. Where occurrences persist on only marginal

habitat, the addition of extreme drought conditions is likely to result in higher rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level; (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example, isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]; and (3) increased competition among urban, agricultural, and natural ecosystem uses due to decreased precipitation. Although the specific effects of climate change on Eryngium constancei are unknown, the effects of increased winter flooding and drought conditions in the spring and summer have the potential to adversely affect this species (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
recommend the recovery priority number be changed from 14 to 8C (USFWS, 2023).

**Delisting Criteria:**
1. Suitable vernal pool habitat within each prioritized core area for the species is protected (USFWS, 2009).

2. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there (USFWS, 2009).

3. Reintroductions must be carried out and meet success criteria established in the recovery plan (USFWS, 2009).

4. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the recovery plan (USFWS, 2009).

5. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

6. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E (USFWS, 2009).

7. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc) (USFWS, 2009).

8. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below

average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

9. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2009).

10. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

11. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2009).

12. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions (USFWS, 2009).

13. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat (USFWS, 2009). protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E

14. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

15. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts (USFWS, 2009).

16. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts (USFWS, 2009).

17. Participation plans for each vernal pool region have been completed and implemented (USFWS, 2009).

18. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

**Recovery Actions:**

- Habitat protection (USFWS, 2005).
- Adaptive habitat management and monitoring (USFWS, 2005).
- Status surveys (USFWS, 2005).
- Research (USFWs, 2005).
- Public participation and outreach (USFWS, 2005).
- Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquire conservation easements or fee title to habitat lands to help guarantee protection of the species in perpetuity (USFWS, 2009).
- Develop and implement standardized population trend survey protocols to complete updated status surveys at all four occurrences (USFWS, 2009).
- Create and convene regional vernal pool working groups in the Lake-Napa Region where Eryngium constancei occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas (USFWS, 2009).
- Collect seeds from populations from which it has not yet been collected following the Center for Plant Conservation Guidelines (1991). Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation (USFWS, 2009).
- Withdraw the proposal to reclassify Eryngium constancei from endangered to threatened (USFWS, 2009).
- Consider modifying the Boggs Lake-Clear Lake core area to incorporate the entire Loch Lomond Vernal Pool Ecological Reserve and adjacent watershed (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Loch Lomond coyote-thistle. Some of these recommendations have already been discussed in the previous 5-year review (Service 2009, pp. 17–18) and remain valid. 1. Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquire habitat through conservation easements or fee title to help guarantee protection of the species in perpetuity. 2. Develop and implement standardized population trend survey protocols to complete updated status surveys at all four occurrences. 3. Create and convene regional vernal pool working groups in the Lake-Napa Region where Loch Lomond coyote-thistle occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for the Loch Lomond coyote-thistle. 4. Collect seeds from populations from which it has not yet been collected following the latest Center for Plant Conservation Guidelines. Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. 5. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data were lacking at the time the Recovery Plan was developed. Therefore, reassess and refine both down- and de-listing criteria for the Loch Lomond coyote thistle, if appropriate, to better reflect the species' life history and narrow range (USFWS, 2023).

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# SPECIES ACCOUNT: *Eryngium cuneifolium* (Snakeroot)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/20/1987; Southeast Region (R4)

**Physical Description**

Eryngium cuneifolium is an aromatic perennial herb with a long, woody taproot, and persistent rosette of dark green. It usually has several erect, branching, flowering stems. It ranges from 0.25 to 0.5 m in height, rarely reaching as high as 0.9 m. The leaves are clustered at the base of the plant. The basal leaves are long, stalked, and shaped like narrow wedges, with 3 to 5 bristle-tipped teeth at the apex. Stem leaves are smaller and lack leaf stalks. The flowers are small, with white petals, filaments, styles and stigmas but powdery blue anthers form small heads, with bristly bracts. The sepals and petals are each about 1.5 to 2 mm long. The inferior ovary develops into a fruit about 1.5 to 2 mm long. The flowers and bristle bracts form heads 4 to 8 mm in diameter (Bell 1963, Wunderlin et al. 1981). Sterile plants are easily recognized in the field by their basal rosettes (Wunderlin et al. 1981). Flowering is from August to October (other Eryngium species, including E. aromaticum and E. baldwinii have blue flowers). (USFWS, 1999)

**Taxonomy**

Eryngium cuneifolium, a member of the parsley family (Apiaceae or Umbelliferae), is most closely related to E. aromaticum (Bell 1963, Wunderlin et al. 1981). It was described by J.K. Small (1933) and its status as a species was upheld by O.R. Bell's (1963) review of the genus. Preparers of status reports (Wunderlin et al. 1981, Kral 1983) have also concurred that this is a distinct species. There are no synonyms in the botanical literature (Bell 1963, Wunderlin et al. 1981). Other common names for this species include wedged-leaved button-snakeroot (Wunderlin et al. 1981) and semantic variations thereof. (USFWS, 1999)

**Historical Range**

This species was first collected in 1927 near Sebring. Highlands County, Florida. (USFWS, 1999)

**Current Range**

Southern Highlands County, Florida, near the town of Lake Placid. It occurs only on the southern Lake Wales Ridge. (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 1999)

**Lifespan**

Adult: short-lived (less than 10 years ) (USFWS, 2019)

**Reproduction Narrative**

Adult: Reproduction in E. cuneifolium is sexual. The species can reproduce readily by seed. There seems to be no special seed-dispersal mechanism (other than gravity) and pollination is likely to be similar to that of other members of Apiaceae, most likely by generalist insects (Wunderlin et al. 1981, Kral 1983). Germination and leafing dates are unknown. Budding is believed to occur in July. The plant flowers vigorously from September through October. Anthesis occurs from August to October . Fruiting and seed dispersal is believed to occur between October and January . Seeds are mature in November. Specimens have been collected in late November and December. (USFWS, 1999)

**Habitat Type**

Adult: Scrub vegetation

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Snakeroot is found in open sand gaps in rosemary habitats within the Lake Wales Ridge in Highlands County. Nearly every aspect of snakeroot's demography is affected by time-since-fire. The beneficial effects of fire are largely indirect, though removal of litter, competing vegetation, and ground lichens. Snakeroot is sensitive to shrub cover and is dependent on the gaps created between rosemary shrubs immediately after fires. (USFWS, 2019)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (inferred) (USFWS, 2019)

**Number of Populations:**

13 occurrences (USFWS, 2019)

**Population Narrative:**

In the last FNAI Element Tracking Summary (FNAI 2015) there were 13 known occurrences, 10 of which were on 5 managed areas. This was a significant decline (approximately 32 percent) from the 19 reported occurrences in the previous 5-year status review (2010c) (USFWS, 2019). Population sizes of snakeroot tend to vary widely with time since fire occurrence (Menges and Quintana-Ascencio 2004). Most EORs do not have regular population size estimates, although some have been reported previously (Service 2010). Population sizes reported by FNAI ranged from 10 to 10,000+ individual plants, but some EORs do not have population sizes indicated (FNAI 2020, Table 1). At ABS, the number of plants in study populations between 2014 and 2019 has ranged from 1,300 to 2,700 individuals, with several hundred additional plants outside of study areas (Menges, unpublished data). At Royce Ranch, plants in plots have varied from about 300 to 500 during the past few years, but there are probably thousands of additional plants at the site (Menges, unpublished data). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic

groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within its historic range, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support E. cuneifolium (USFWS, 1999)

4. When monitoring programs demonstrate that populations of E. cuneifolium on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**

- Determine current distribution of E. cuneifolium. This species has been relatively well surveyed and a distribution has been ascertained. Additional surveys will confirm the species’ distribution and locate new sites. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)

- Conduct research on life history characteristics of E. cuneifolium. Continue the study of basic biology and ecology of this species. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of E. cuneifolium. Develop monitoring protocol to assess population trends for E. cuneifolium. Develop a quantitative description of the population structure of E. cuneifolium. (USFWS, 1999)
- Provide public information about E. cuneifolium. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about E. cuneifolium. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of E. cuneifolium and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Introduce plants to suitable, managed habitats to increase the number of such populations to 20. • Continue demographic monitoring and expand to additional occurrences, especially those that are protected. Menges et al. (2019) suggest level 3 demographic monitoring as the highest priority. • Advocate and support the application of prescribed fire on managed areas to maintain rosemary scrub habitat for snakeroot. • Ensure representation of snakeroot at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. • Service recovery leads should maintain open lines of communication with State land managers and provide updates as appropriate to ensure proper management of occurrences. • Continue to improve the capacity for planting snakeroot as part of restoration efforts. • Acquire land with existing populations from willing sellers and restore scrub habitat on these sites, including the implementation of prescribed fire. • Utilize outreach and assistance programs to encourage private landowners to protect and manage scrub habitat on private lands. (USFWS, 2021)

**References**

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Ziziphus celata (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

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USFWS. 2021. Snakeroot (Eryngium cuneifolium) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service South Atlantic-Gulf Region Florida Ecological Services Field Office Vero Beach, Florida. 16 pp.

# SPECIES ACCOUNT: *Eryngium sparganophyllum* (Arizona eryngo)

***Species Taxonomic and Listing Information***

**Listing Status:** Proposed Endangered

**Physical Description**

Arizona eryngo is an herbaceous perennial dicot that grows to a height of about 1.5 meters (m) (~5 feet [ft]) with long, linear, parallel-veined leaves that emerge from a basal rosette (Stromberg et al. 2019, p. 3, Makings 2013, p. 74) (Figure 2.1). The plant is conspicuous when flowering (Makings 2013, p. 74) in June through September (Stromberg et al. 2019, p. 8; New Mexico Rare Plants 2013, p 1). The flowers are cream-colored and clustered in dense heads at the end of the branching, scapose inflorescences (Stromberg et al. 2019, p. 3; Makings 2013, p. 74). The flower heads are ovoid or ovoid-oblong and are 12-25 millimeters (mm) (0.47-0.98 inch [in]) long and 10-15 mm (0.39-0.59 in) wide, with several ovate or lanceolate basal bracts and similar, but smaller bractlets within the head that barely exceed to the length of the fruits (New Mexico Rare Plants 2013, p 1). The fruit, a schizocarp splitting into two mericarps, is ovoid and 3-4 mm (0.12-0.16 in) long (Stromberg et al. 2019, p. 8; New Mexico Rare Plants 2013, p 1). Root depth is uncertain, but roots grow to at least 20 cm and likely beyond (Li personal communication December 11, 2019) (USFWS, 2020).

**Taxonomy**

Eryngium sparganophyllum is an herbaceous perennial flowering plant in the Apiaceae, or carrot family (Wooton and Standley 1915, 475-478; Hooker 1897, p. 42). Arizona eryngo is one of about 250 species in the genus worldwide (Calviño et al. 2008, p. 1130); it is one of 30 Eryngium species native to the U.S. (with an additional two in the U.S. that are naturalized), and one of five known from Arizona, although one (E. phyteumae) has not been seen since 1882 (Calviño personal communication April 5, 2020). Arizona eryngo was first described by botanist William Hemsley and illustrated by Matilda Smith in Hooker's Icones Plantarum (Hooker 1897, p. 42) from the specimens collected by Charles Wright at Las Playas, New Mexico (the type locality) in 1851 (Stromberg et al. 2019, p. 4; Wooton and Standley 1915, p. 478; Hooker 1897, p. 42) (USFWS, 2020). Hemsley and illustrated by Matilda Smith in Hooker's Icones Plantarum (Hooker 1897, p. 42) from the specimens collected by Charles Wright at Las Playas, New Mexico (the type locality) in 1851 (Stromberg et al. 2019, p. 4; Wooton and Standley 1915, p. 478; Hooker 1897, p. 42).

**Historical Range**

Arizona eryngo is known historically from six sites: three sites in Arizona and one in New Mexico in the U.S., and one site in Sonora and one site in Chihuahua in Mexico (Sánchez Escalante et al. 2019, pp. 16-17; Stromberg et al. 2019, pp. 3-8) (USFWS, 2020).

**Critical Habitat Designated**

Yes; 7/11/2022.

**Legal Description**

We, the U.S. Fish and Wildlife Service (Service), determine endangered species status under the Endangered Species Act of 1973 (Act), as amended, for the Arizona eryngo (Eryngium sparganophyllum), a plant species native to Arizona and New Mexico in the United States, and to Sonora and Chihuahua in Mexico. We also designate critical habitat for the Arizona eryngo. In total, approximately 12.7 acres (5.1 hectares) in Pima and Cochise Counties, Arizona, fall within the boundaries of the critical habitat designation. This rule extends the protections of the Act to this species and its designated critical habitat.

**Critical Habitat Designation**

Critical habitat units are depicted for Pima and Cochise Counties, Arizona

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the physical or biological features essential to the conservation of Arizona eryngo consist of the following components:

(i) Cienegas within the Chihuahuan and Sonoran Deserts: (A) That contain permanently moist to saturated, organic, alkaline soils with some standing water in winter and that are moist at or just below the surface in summer; and (B) That have functional hydrological processes and are sustained by springflow via discharge of groundwater.

(ii) Areas of open canopy throughout the cienega.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the following threats: physical alteration of cienegas, water loss, and changes in co-occurring vegetation. Management activities that could ameliorate these threats include, but are not limited to: Use best management practices (BMPs) to minimize erosion and sedimentation; remove and control invasive, nonnative species (e.g., Johnsongrass) that encroach on critical habitat; selectively manage woody vegetation that encroaches on critical habitat; exclude livestock, or in some instances where such management would further the conservation of cienega habitat and the species, use highly managed grazing; avoid or minimize groundwater withdrawal to maintain adequate springflow to maintain cienegas; and avoid springflow diversion and springhead modification to maintain springflow to cienegas.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Cross pollination (USFWS, 2020)

**Reproduction Narrative**

Adult: Arizona eryngo grown in nurseries can flower in their first year. At natural sites, plants flower from June to September (Stromberg et al. 2019, p. 8; New Mexico Rare Plants 2013, p 1). Dry fruits ripen in September and October (Li 2020, p. 2; AGFD 2019, p. 2; Stromberg et al. 2019, p. 8). Stromberg et al. (2019, p. 8) studied plants at Lewis Springs and found that mature plants in 2018 produced an average of 1.75 flowering stalks, each with an average of 3.4 inflorescences per stalk (up to 12 inflorescences per stalk had been observed in prior years). In 2014, they found that each inflorescence contained an average of 96 flowers and therefore, given the two seeds per fruit, estimated that an individual plant could produce several hundred seeds per season. They reported that the observed number of flowering stalks was considerably lower at Lewis Springs in 2018 than in prior years, as surface soils were subjectively drier, with saturated conditions detected only when excavating several centimeters (cm) into the wetland soils. Li (2019, p. 8), based on his observations of the species at La Cebadilla, also hypothesizes that flowering is determined by soil moisture availability and temperature (i.e., summer warmth) Aboveground, plants dieback partially or completely in the winter months such that almost no green or very little green aboveground structure can be seen (Li 2020, p. 9). While little is known about the reproductive strategy/ecology of Arizona eryngo, it is likely that pollinators are required for cross-pollination in this species. Pollinators do not seem to be lacking and abundant animal activity on the flowers is readily observed (Li, p. 8; J. Simms 2019, p. 1, Stromberg et al. 2019, p. 8). Another Eryngium similar in appearance to Arizona eryngo, E. yuccifolium (rattlesnake master) is xenogamous species (transfer of pollen grains from the anther to the stigma of a different plant) with temporal dioecism (Molano-Flores 2001, p. 5). Temporal dioecism is a synchronized flowering sequence that allows pollen to be shed before any stigma becomes receptive, minimizing geitonogamous pollinations (the fertilization of a flower by pollen from another flower on the same or a genetically identical plant) and maximizing outcrossing (Molano-Flores 2001, p. 5). The patterns of seed dispersal, germination percentages, and the rates of seedling establishment in the wild are not known (AGFD 2019, p. 2; Stromberg et al. 2019, p. 8). Arizona eryngo seeds are large and heavy and therefore are not likely to fall far from the mother plant. The height and the swaying of the inflorescence suggests that seeds may be dispersed by wind, but only short distances. Barbs around the seeds, however, likely function as hooks that may enable dispersal via attachment to mammals and birds (Blackwell et al. personal communication May 8-11, 2020). (USFWS, 2020).

**Habitat Type**

Adult: Spring-fed cienegas (USFWS, 2020)

**Habitat Narrative**

Adult: Arizona eryngo requires perennially moist, organic alkali soils found in spring-fed cienegas supported by adequate groundwater (Figure 2.3). Plants grow best in full sun in areas with few nonnative plant species, limited woody vegetation, or other vegetation that may shade or otherwise outcompete them. While the species reproduces asexually, pollinators are likely needed for sexual reproduction necessary to maintain genetic diversity (USFWS, 2020). The species is a habitat specialist and occurs in open, sunny, spring-fed cienega wetlands where soils are organic, alkali, and perennially moist. Plants grow best in full sun in areas with few nonnative plant species, limited woody vegetation, and other vegetation that may shade or otherwise outcompete them. (USFWS, 2024)

***Dispersal/Migration***

**Dispersal**

Adult: Unknown (USFWS, 2020)

**Dispersal/Migration Narrative**

Adult: The patterns of seed dispersal, germination percentages, and the rates of seedling establishment in the wild are not known (AGFD 2019, p. 2; Stromberg et al. 2019, p. 8). Arizona eryngo seeds are large and heavy and therefore are not likely to fall far from the mother plant. The height and the swaying of the inflorescence suggests that seeds may be dispersed by wind, but only short distances. Barbs around the seeds, however, likely function as hooks that may enable dispersal via attachment to mammals and birds (Blackwell et al. personal communication May 8-11, 2020). (USFWS, 2020)

***Population Information and Trends***

**Number of Populations:**

4 population areas (USFWS, 2025)

**Population Size:**

30,422 genets or aggregates with a 95% confidence interval of the population size (USFWS, 2020). The remaining populations are isolated from one another, and as of 2018 to 2020, estimates indicate there is a range of 56 to 31,467 individuals per population (USFWS, 2025)

**Population Narrative:**

The Arizona eryngo population is estimated to be 30,422 genets or aggregates with a 95% confidence interval of the population size, according to the boostrapping estimation, of (19,289, 43,469) genets at Lewis Springs (Li 2020b, p. 1). (Li 2020b, p. 1). As described in section 2.3, each clone has a unique basal stem, and multiple clones can form a clustered aggregate that resembles an individual plant (Li 2020a, p. 2). Li (2020a, p. 2, 2020b, p. 1) refers to such an “individual plant” as a clonal aggregate or genet, which is the basic unit of Arizona eryngo population size. Stromberg et al. (2019, p. 6) estimated Arizona eryngo population size at La Cebadilla in the low thousands (calculated using the estimated spatial extent of 4,494 m2 and assumption of a minimum of one plant per 2 m2 quadrat). Further study indicates that the mean number of individuals per 1m2 (in 30 established study plots) was 6.7, which explains why Stromberg et al.’s (2019) estimate was lower. While this is the largest of the four extant populations, the plants occur in a very confined space and remain tied to the fate of the cienega. The La Cebadilla Cienega occurs within Arizona Upland subdivision of Sonoran Desert Scrub at about 825 m (2,707 ft) in elevation. The climate is semiarid with a mean annual temperature of 20 degrees C and mean annual precipitation of 337 mm (13.27 in) (Stromberg et al. 2019, p 5; Wolkis 2016, p. 35). At this site, Arizona eryngo is primarily associated with Eleocharis palustris, Muhlenbergia asperifolia, Schoenoplectus americanus, and Anemopsis californica. Other associates of Arizona eryngo at La Cebadilla Cienega were Almutaster pauciflorus, Distichlis spicata, Eustoma exaltatum, Juncus balticus and Sisyrinchium demissum (Stromberg et al. 2019, p. 6) (USFWS, 2020). Arizona eryngo is known historically from six sites in Arizona, New Mexico (now extirpated), Sonora, and Chihuahua at elevations ranging from 825 to 1,492 m (Table 1, Figure 1). Four of six of the spring-fed cienegas were/are thermal springs (Agua Caliente, Arizona; Las Playas, New Mexico; Rancho Agua Caliente, Sonora; and Ojo Vareleño, Chihuahua). The species was extirpated from two known sites (one site in Arizona [Agua Caliente] and one site in New Mexico [Las Playas]) but remains extant at the other four sites (two in Arizona [Lewis Springs and La Cebadilla], one in Sonora [Rancho Agua Caliente], and one in Chihuahua [Ojo Vareleño]). The remaining populations are isolated from one another, and as of 2018 to 2020, estimates indicate there is a range of 56 to 31,467 individuals per population (Table 1). In the SSA, we consider a population to have high resiliency if it has more than 1,840 plants, moderate resiliency if it has between 800 and 1,840 plants, and low resiliency if it has between 50 and 799 plants. A population with fewer than 50 plants is considered functionally extirpated. We have defined four representation areas based on river basin boundaries and geographic separation of known historical populations (Figure 1). The four populations and river basins of representation are: 1) the La Cebadilla population in the Santa Cruz River Basin, 2) the Lewis Springs population in the San Pedro River Basin, 3) the Rancho Agua Caliente population in the Rio Bavispe River Basin, and 4) the Ojo Vareleño population in the Rio Casas Grandes (Mimbres) Basin. Recovery criteria are based on populations within these four representation areas. (USFWS, 2024) The species is presumed extirpated from two known sites (one site in Arizona [Agua Caliente] and one site in New Mexico [Las Playas]) but remains extant at the other four sites (two in Arizona [Lewis Springs and La Cebadilla], one in Sonora [Rancho Agua Caliente], and one in Chihuahua [Ojo Vareleño]). The remaining populations are isolated from one another, and as of 2018 to 2020, estimates indicate there is a range of 56 to 31,467 individuals per population (Table 1). In the SSA, we consider a population to have high resiliency if it has more than 1,840 plants, moderate resiliency if it has between 800 and 1,840 plants, and low resiliency if it has between 50 and 799 plants. A population with fewer than 50 plants is considered functionally extirpated. We have defined four representation areas based on river basin boundaries and geographic separation of known historical populations (Figure 1). The four populations and river basins of representation are: 1) the La Cebadilla population in the Santa Cruz River Basin, 2) the Lewis Springs population in the San Pedro River Basin, 3) the Rancho Agua Caliente population in the Rio Bavispe River Basin, and 4) the Ojo Vareleño population in the Rio Casas Grandes (Mimbres) Basin. Recovery criteria are based on populations within these four representation areas. (USFWS, 2025)

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5C

1. Fourteen or more populations of Arizona eryngo are viable throughout the species' geographic range in the U.S. and Mexico, including populations in the four representation areas as follows: a. Santa Cruz River Basin: at least four populations, including La Cebadilla and three additional populations that are newly discovered or introduced (these may include Agua Caliente, Canoa, Bar V, and LCNCA). b. San Pedro River Basin: at least two populations, including Lewis Springs and one additional population that is newly discovered or introduced. c. Rio Bavispe River Basin: at least two populations, including Rancho Agua Caliente and one additional population that is newly discovered or introduced, or two populations that are newly discovered or introduced. d. Rio Casas Grandes Basin (Mimbres): at least four populations, including Ojo Vareleño and three additional populations that are newly discovered or introduced, or four populations that are newly discovered or introduced. e. Two additional populations that are

newly discovered or introduced in any existing or new representation area. Introduced populations are created using appropriate genetic stock and are placed in suitable habitat and microhabitat. Of the 14 populations referenced above, at least: a. One population supports more than 30,000 adult individuals (i.e., genets), b. One population supports more than 1,840 adult individuals (i.e., genets), c. Six populations support more than 800 adult individuals (i.e., genets), d. Six populations support more than 100 adult individuals (i.e., genets). The total number of adult individuals may be spatially distributed in subpopulations within a population (i.e., the subpopulations must be close enough to interact via pollination). These population numbers will be maintained (natural recruitment is greater than or equal to documented plant loss) for a total of at least 5 years over the last 10-years of the period prior to downlisting (20 years), as indicated by monitoring every 1 to 3 years, including during the three most recent monitoring events. This allows for some fluctuation in population abundance due to drought or other threats. (USFWS, 2025)

2. A collection of seed representing the geographical, morphological, and genetic diversity of Arizona eryngo is started within 5 years of the finalization of this recovery plan, with regular supplemental collections, and maintained in at least one Center for Plant Conservation partner, or botanical or seed storage institution for conservation purposes. (USFWS, 2025)

3. A living collection of plants representing the geographical, morphological, and genetic diversity of Arizona eryngo is started within 5 years of the finalization of this recovery plan, with needed supplemental collections, and maintained long-term in at least one botanical institution for educational and conservation purposes. (USFWS, 2025)

4. Lands supporting 10 of 14 populations of Arizona eryngo are protected in perpetuity through a conservation easement, habitat conservation plan, or other conservation mechanism appropriate to the land status. (USFWS, 2025)

5. Conservation and management programs and plans address the threats to Arizona eryngo, including cienega habitat loss, drying, and alteration; changes in co-occurring vegetation; and direct harm to Arizona eryngo. The following must be met: a. site-specific plans are developed and at least partially implemented, such that: i. competing native and nonnative vegetation is reduced to a level that ensures Arizona eryngo is not shaded and that the vigor of mature plants and seedlings is not negatively affected (Factor A), ii. a more natural fire or other disturbance regime (e.g., mechanical vegetation removal, prescribed grazing) is promoted (Factor A), iii. natural spring flow supporting cienegas is increased by reducing water loss (from groundwater pumping, etc.) and increasing water conservation and recharge (Factor A), iv. moist soil cienega habitat is increased (Factor A), v. herbivory and trampling are managed to benefit species survival (Factor C), and vi. native plant diversity is maintained or increased, thus promoting native pollinators; and b. data on the conservation and management of Arizona eryngo are collected and shared among landowners, managers, and researchers. (USFWS, 2025)

**Delisting Criteria:**
1. Fourteen or more populations of Arizona eryngo are viable throughout the species' geographic range in the U.S. and Mexico, including populations in the four representation areas as follows: a. Santa Cruz River Basin: at least four populations, including La Cebadilla and three additional populations that are newly discovered or introduced (these may include Agua Caliente, Canoa, Bar V, and LCNCA). b. San Pedro River Basin: at least two populations, including

Lewis Springs and one additional population that is newly discovered or introduced. c. Rio Bavispe River Basin: at least two populations, including Rancho Agua Caliente and one additional population that is newly discovered or introduced, or two populations that are newly discovered or introduced. d. Rio Casas Grandes River Basin: at least four populations, including Ojo Vareleño and three additional populations that are newly discovered or introduced, or four populations that are newly discovered or introduced. e. Two additional populations that are newly discovered or introduced in any existing or new representation area. (USFWS, 2025)

2. A collection of seed representing the geographical, morphological, and genetic diversity of Arizona eryngo is started within 5 years of the finalization of this recovery plan, with regular supplemental collections, and maintained in at least one Center for Plant Conservation partner botanical or seed storage institution for conservation purposes. (USFWS, 2025)

3. A living collection of plants representing the geographical, morphological, and genetic diversity of Arizona eryngo is started within 5 years of the finalization of this recovery plan, with needed supplemental collections, and maintained in long-term in at least one botanical institution for educational and conservation purposes. (USFWS, 2025)

4. Lands supporting 12 of 14 populations of Arizona eryngo are protected in perpetuity through a conservation easement, habitat conservation plan, or other conservation mechanism appropriate to the land status. (USFWS, 2025)

5. Conservation and management programs and plans address the threats to Arizona eryngo, including cienega habitat loss, drying, and alteration; changes in co-occurring vegetation; and direct harm to Arizona eryngo. The following must be met: a. site-specific plans are developed and fully implemented, such that: competing native and nonnative vegetation is reduced to a level that ensures Arizona eryngo is not shaded, and that the vigor of mature plants and seedlings are not negatively affected (Factor A), i. a more natural fire or other disturbance regime is promoted (Factor A), ii. natural spring flow supporting cienegas is increased by reducing water loss (from groundwater pumping, etc.) and increasing water conservation and recharge (Factor A), iii. moist soil cienega habitat is increased (Factor A), iv. herbivory and trampling are minimized (Factor C), and v. native plant diversity is maintained or increased, thus promoting native pollinators; and b. data on the conservation and management of Arizona eryngo are collected and shared among landowners, managers, and researchers. (USFWS, 2025)

**Recovery Actions:**

- Objective 1. Increase the size and number of populations (i.e., improve resiliency and redundancy) through Arizona eryngo augmentation and introduction success. (USFWS, 2025)
- Objective 2. Ensure long-term Arizona eryngo conservation through the establishment of ex-situ plant and seed collections housed at multiple Center for Plant Conservation approved botanical institutions and seed banks. (USFWS, 2025)
- Objective 3. Improve our understanding of the status and conservation needs of Arizona eryngo and its habitat through monitoring and research and practice adaptive management in which recovery is monitored and recovery tasks are revised by the USFWS in coordination with partners as new information becomes available. (USFWS, 2025)
- Objective 4. Reduce threats of loss and alteration of cienegas and water loss from cienegas through the protection, restoration, and proper management of adequate quantity and

quality of functional cienega habitat within existing, newly discovered, and introduced Arizona eryngo populations. (USFWS, 2025)

- Objective 5. Reduce threats from changes in co-occurring vegetation to Arizona eryngo habitat within existing, newly discovered, and introduced Arizona eryngo populations. (USFWS, 2025)
- Objective 6. Identify and reduce other threats (e.g., unsustainable levels or timing of predation or herbivory, trampling, pollinator loss), as needed, to Arizona eryngo growth, reproduction, and recruitment within existing, newly discovered, and introduced Arizona eryngo populations. (USFWS, 2025)
- Objective 7. Ensure long-term Arizona eryngo conservation through adequate funding, public education and outreach, and partnerships. (USFWS, 2025)

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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**References**

United States Fish and Wildlife Service. 2020. Species status assessment report for Eryngium sparganophyllum (Arizona eryngo). United States Fish and Wildlife Service, Tucson, Arizona.

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# SPECIES ACCOUNT: *Erysimum capitatum var. angustatum* (Contra Costa wallflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 05/27/1978; Pacific Southwest (R8)

**Physical Description**

a short-lived perennial and monocarpic (individuals die after setting seed) (Service 1984). Pollination is by bees that nest in open banks and may also be by a variety of other unspecified insects (Service 2002). A study in 1987 by Pavlik et al (1998a) determined that seed production for E.c. var. angustatum was not a limiting factor and germination of new seeds was considered relatively high, with 40-60% typical, comparable to germination rates in non-endangered relatives. Additional work by Pavlik et al (1988b) determined that, at that time, the growth of E.c. var. angustatum populations was not genetically constrained, but was environmentally constrained due to limited habitat, interspecific vegetation competition, and possibly pollination limitations. Seedling emergence (and presumably, germination) was significantly higher in dune soils than unbroken clay soil, and higher (but not significantly) in dune soil than in broken clay soil (Pavlik et al 1988b). The reproductive phenology encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting beginning in April and peaking in July (Service 2008). (USFWS, 2019)

**Taxonomy**

Note that Erysimum asperum var. angustatum is a different plant, treated as a synonym of the typical E. capitatum var. capitatum by Kartesz (1994 checklist), recognized as a full species (E. angustatum) in Kartesz (Feb. 1999 draft data). Reports of the Contra Costa wallflower from Alaska and Canada are presumably due to confusion of these two similar names (NatureServe, 2015). The Contra Costa wallflower is one of the many varieties of the western wallflower (Erysimum capitatum). A member of the Brassicaceae (mustard) family (USFWS 1984) (USFWS, 2008).

**Historical Range**

The Contra Costa wallflower is endemic to the riverine dune habitat found within and immediately adjacent to the Antioch Dunes NWR in Contra Costa County, California. (USFWS, 2008)

**Current Range**

This species is only known known from the Antioch Dunes in Contra Costa County, California. (USFWS, 2008)

**Critical Habitat Designated**

Yes; 8/31/1978.

**Legal Description**

On August 31, 1978, the U.S. Fish and Wildlife Service, designated critical habitat for Erysimum capitatum var. angustatum (Contra Costa wallflower) under the authority of the Endangered Species Act of 1973 (43 FR 39042 - 39044). Critical habitat was designated for one unit in

California.

**Critical Habitat Designation**

One critical habitat unit is designated in California, described as: An area of land, water, and airspace in Contra Costa County with the following components: T. 2 N. R. 2 E. SW 1/4 section 17, E 2/3 of S 1/3 of section 18 (43 FR 39042 - 39044).

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements are not described (43 FR 39042 - 39044).

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2008)

**Lifespan**

Adult: 2+ years (USFWS, 2008)

**Breeding Season**

Adult: March - May (USFWS, 2008)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2008)

**Reproduction Narrative**

Adult: This species is a biennial or short-lived perennial. The reproductive phenology of this species encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting in April (peaking in July). Unlike other members of the mustard family, pollination of the Contra Costa wallflower is by a variety of unspecialized insects, including bees nesting along the open banks (USFWS 2002) (USFWS, 2008). According to Harper (1977), it may best be thought of as a monocarpic perennial (USFWS, 1984).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2008)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland, sand dune, savanna, shrubland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Wind disturbance regime (USFWS, 2008)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs at 3 - 20 m elevation (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2008)

**Habitat Narrative**

Adult: Inhabits inland dunes at 3 - 20 m elevation (Skinner 1997). More or less consolidated (stabilized) dunes of fine sand and some clay dust, with sparse herbs and shrubs, or less often with pasture grasses, herbs, and scattered Quercus agrifolia (Niehaus 1977) (NatureServe, 2015). The wallflower grows in soil types classified as sand to sandy loam. Precise information about the specific requirements of the Contra Costa wallflower are not well known; however, the plant has been observed growing in steep areas of unstable sand, especially on north-facing slopes adjacent to the river (USFWS 1984, 2002; S. Euing, USFWS, pers. comm. 2007). This plant has also been observed growing in a variety of conditions, including stable dunes of fine sand containing some clay and sparsely vegetated with herbs and shrubs; uneven river front bluff faces and edges; flat terrain in excavated areas; and flat hard pan areas 160 to 660 feet from the river where the hard pan is broken and loose, sandy soil is exposed (USFWS 2002). A natural disturbance regime is caused by the wind shifting the sandy environment in which the Contra Costa wallflower thrives (USFWS, 2008).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are wind-dispersed beginning in mid-May and peaking in September (USFWS, 2008).

***Population Information and Trends***

**Population Trends:**

not considered stable or self-sustaining (USFWS, 2019)

**Species Trends:**

not considered stable or self-sustaining (USFWS, 2019)

**Number of Populations:**

4 (USFWS, 2019)

**Population Size:**

Approximately 9,287 individuals in 2017 (USFWS, 2019)

**Population Narrative:**

According to the CNDDB (2018b), Erysimum capitatum var. angustatum is known from four EOs, all of which are presumed extant (Table 3). Of the four EOs, three are considered natural occurrences and one is considered transplanted outside of native habitat and/or range. The two CNDDB EOs that occur at the ADNWR (EO #1, which includes the Stamm Unit and EO #3, which includes the Sardis Unit) represent the majority of, and possibly the entire, known range-wide natural/native population. Nearly annual plant counts have been conducted in at least some of the subunits of the Stamm and Sardis Units since about 1985. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction from sand mining, industrial and urban/suburban development, and/or conversion to agriculture (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat for the this species and pollinators, and area available for habitat restoration is threatened by destruction and conversion to other uses. This threat is largely ameliorated on the ADNWR and other properties with protection/management agreements in place, but not on properties without such agreements. (USFWS, 2019)

**Stressor:** Habitat degradation due to loss of natural disturbance regime (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The reduction in sand deposition in Antioch Dunes habitat as a result of water management/use (dams, levees, etc.) in the Sacramento/San Joaquin River Delta system and reduced effectiveness of wind-driven dispersal of sand and disturbance of dunes has and continues to reduce overall size and connectedness of the dune natural community. (USFWS, 2019)

**Stressor:** Habitat degradation due to non-native and native invasive vegetation (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive vegetation colonizes open sand habitat, reducing available suitable E.c. var. angustatum, and pollinator, habitat. Invasive plants out-compete native species, including E.c. var. angustatum, for sunlight, space, nutrients, and moisture. They also stabilize the sand/soil, eliminating the natural disturbance regime and may cause soils to become more eutrophic (Thomson 2005a, Thomson 2005b, Chin 2012, McNally 2014). The 2008 Five-Year Review notes that the proliferation of non-native invasive plants has been increasing rapidly since 1998 (Service 2008) and these conditions continue (Chin 2012, McNally 2014, Service 2018a, Service 2018b, Service 2018c, Service 2018d). The use of herbicides to control non-native and native invasive vegetation may also present potential threat to E.c. var. angustatum occurring in the same vicinity. Applying herbicides selected for the target species and using appropriate rates and technique should minimize effects to non-target E.c. var. angustatum. These practices have been instituted at the ADNWR, so this threat is considered largely ameliorated there (Service 2008), but it may pose a risk to current and future occurrences of these listed species elsewhere. (USFWS, 2019)

**Stressor:** Habitat degradation due to gypsum dust deposition from neighboring plant (facility) (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 2008 Five-Year Review reported that gypsum dust building up on plants may reduce exposure to sunlight and decrease photosynthesis. It may also alter soil chemistry due to introduction of calcium and sulphates, which may affect the growth of E.c. var. angustatum and promote colonization by invasive species. Deposition is noted as affecting mostly the Sardis Unit.

The ADNWR staff have met with Georgia-Pacific (G-P) about concerns over the dust and G-P increased efforts to reduce airborne gypsum (beyond the standards for air pollution control) by keeping it wetted down when possible during production activities. At the time of the 2008 Five-Year Review, staff noted a reduction in dust from G-P efforts. The review noted that there was no evidence that gypsum dust was adversely affecting any of the three species (Service 2008). However, it also cited a study that demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1945 in Service 2008), which may affect pollinators of O.d. subsp. howellii or E.c. var. angustatum. The ADNWR staff reported an increase in gypsum dust deposition at ADNWR in 2017-2018 (Susan Euing pers. comm. December 12, 2018). In 2018, staff noted that gypsum was being deposited on the refuge at concentrations that coats plants, leading to cancellation of surveys for the Lange’s metalmark in some parts of the refuge (Susan Euing pers. comm. August 17, 2018). In 2019, after several weeks into the Lange’s metalmark survey season, ADNWR staff confirmed that no surveys had been canceled due to concerns about gypsum dust deposition (Louis Terrazas pers. comm. September 10, 2019). The magnitude of this potential stressor requires further investigation and Service partnership with G-P is ongoing. (USFWS, 2019)

**Stressor:** Habitat degradation due to rogue hiking/trails (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This activity may cause direct injury or mortality E.c. var. angustatum from trampling while also increasing potential for accidental introduction of wildfire from hikers. These threats and stressors were significantly reduced when ADNWR was fenced in 1986 and the 2008 Five-Year Review (Service 2008) no longer considered recreational and pedestrian traffic to be a significant threat. However, ADNWR staff note that incidence of trespassing and human encampments at ADNWR has increased in the past several years (Susan Euing pers. comm. December 12, 2018). (USFWS, 2019)

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** These activities represent a threat to the Antioch Dunes species from direct mortality of any individual(s) collected and a reduction in annual recruitment by killing or injuring reproductive individuals. (USFWS, 2019)

**Stressor:** Disease or predation (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Three moth taxa are known to prey upon E.c. var. angustatum; a fairy moth (Chalceopla simpliciealla), an egg-eating moth (Calcus spp.), and the diamond back moth (Plutella xylostella) (Service 2008). Pavlik et al (1988b) determined that pre-dispersal predation of seeds significantly impacted reproduction during studies conducted in 1987 and 1988. The magnitude of this stressor requires further investigation. (USFWS, 2019)

**Stressor:** Wildfire (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Wildfire may cause direct mortality of E.c. var. angustatum plants during vulnerable life stages. These stages include the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. However, historical evidence indicates that the native plants may recover rather quickly from a wildfire (Service 2008). Any mortality would also result in reduced annual recruitment by killing or injuring reproductive individuals. The threat extends to pollinators and other pollinator plant species. (USFWS, 2019)

**Stressor:** Fuelbreak discing (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fuelbreak discing may cause direct injury or mortality to E.c. var. angustatum. However, it also creates open, disturbed, sand/soil that may be suitable for colonization by E.c. var. angustatum, as well as invasive vegetation. The net impact of this activity to listed plant resilience is unquantified. (USFWS, 2019)

**Stressor:** Loss of pollinators (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Lange’s metalmark is addressed as a pollinator for this discussion of the potential threat posed by possible insecticide drift from mosquito abatement spraying on neighboring properties (Richmond et al 2015). The Mosquito Abatement District allows for spraying of insecticides to reduce the incidence of West Nile Virus at a wetland adjacent to the Stamm Unit of the ADNWR. The spray could drift on to the refuge and affect pollinators, such as Lange’s metalmark and those that pollinate E.c. var. angustatum. While ADNWR staff have worked with county mosquito control staff to minimize effects from this potential threat, the magnitude of this stressor requires further investigation. As of the 2008 Five-Year Review, there was no evidence that lack or loss of pollinators has negatively impacted or E.c. var. angustatum (Service 2008), but the species requires cross-pollination, so an adequate pollinator population is necessary. Bees are suspected pollinators for both species and hawkmoths may also be pollinators for the primrose; however, actual pollinator taxa are unknown. This potential threat requires investigation. (USFWS, 2019)

**Stressor:** Low population numbers (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** E.c. var. angustatum is threatened by few and small populations that are limited to a small and localized distribution, which increases the risk of extirpation and extinction due to: (1) Reduced resiliency (the ability of a species to withstand stochastic disturbance; resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations); (2) Low redundancy (spreading risk among multiple populations or a large

area to minimize the potential loss of the species from catastrophic events); and (3) Low representation (the breadth of genetic and environmental diversity within and among populations that influences the ability of a species to adapt to changing environmental conditions over time). (USFWS, 2019)

**Stressor:** Climate change (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** E.c. var. angustatum is threatened by multiple environmental effects anticipated with climate change, which may result in loss of habitat, altered temperature and moisture regimes causing direct mortality and/or impaired reproduction, and altered temperature and moisture regimes causing indirect mortality and/or impaired reproduction via phenological mismatches with pollinators and between pollinators and their host and/or other nectar plants (Richmond et al 2015). (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
Erysimum capitatum var. angustatum will be considered for downlisting when: 1. There are at least five separate self-sustaining (all plants are naturally recruiting) populations of: at least three populations, each with a 15-year moving median of at least 7,000 flowering plants; and least two populations, each with a 15-year moving median of at least 4,000 flowering plants. (a) A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. (b) Populations should be protected and have in place a long-term management plan for the conservation of E.c. var. angustatum and commitment for implementation of the plan. (USFWS, 2019)

Any flowering individuals counted as naturally recruiting would have to be ≥ two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ. (USFWS, 2019)

**Delisting Criteria:**
Erysimum capitatum var. angustatum will be considered for delisting when: 1. There are at least seven separate self-sustaining (all plants are naturally recruiting) populations of: at least five populations, each with a 15-year moving median of at least 7,000 flowering plants; and at least two populations, each with a 15-year moving median of at least 4,000 flowering plants. OR, population viability analysis determines that E.c. var. angustatum has a range-wide 95% probability of persistence over a 100-year period. (a) A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. (b) Populations should be protected and have in place a long-term management plan for the conservation of E.c. var. angustatum and commitment for implementation of the plan. (USFWS, 2019)

2. A post-delisting monitoring plan for the species has been developed. (USFWS, 2019)

Any flowering individuals counted as naturally recruiting would have to be ≥ two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ. (USFWS, 2019)

**Recovery Actions:**

- Protect Antioch Dunes ecosystem and essential habitat for the Contra Costa wallflower (USFWS, 1984).
- Restore Antioch Dunes ecosystem, and increase numbers and improve habitat for the Contra Costa wallflower (USFWS, 1984).
- Initiate information and education programs (USFWS, 1984).
- Recommended Actions from 2008 5-Year Review: Continue restoration of riverine dune habitat at Antioch Dunes NWR. - Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys. - Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR. - Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Several areas of future action are suggested over the next five years, which build on the actions articulated in the revised recovery plan (Service 1984) and the riverine dune ecosystem conservation strategies articulated in Service (2019b). These areas include: continuing to restore riverine dune habitat at ADNWR and considering nearby locations for restoration activities; continuing to collect and bank seeds, and propagating and out-planting seedlings; continuing research on habitat requirements, life history, and seed bank dynamics; improving statistical analysis and numerical modeling related to Erysimum capitatum var. angustatum; considering development of a publicly-accessible website for documents, literature, and data related to Erysimum capitatum var. angustatum; and establishing an Antioch Dunes Recovery Implementation Team or recovery working group. Continued research on the habitat requirements and seed bank dynamics of Erysimum capitatum var. angustatum could include identifying areas for possible development of new populations of Erysimum capitatum var. angustatum. For example, the Service's experience with dune restoration at the Refuge provides a strong foundation for expanding dune restoration work over the coming years. This future work could include an analysis of how environmental variables, such as precipitation and temperature patterns, and seeding and out-planting influence population dynamics in currently occupied areas and colonization of newly restored dunes. The status of the assemblage of invertebrate species that pollinate Erysimum capitatum var. angustatum is not currently clear. A study of the current pollinators of wallflower at Antioch Dunes would help add to the Service's understanding of the natural history of this plant and identify which potential pollinators, or groups of pollinators, to monitor to ensure that healthy and diverse pollinator populations continue to occur at and near the Antioch Dunes ecosystem. Statistical and numerical modeling, such as with habitat suitability analysis and population dynamics modeling, can provide insights into possible future locations for development of Erysimum capitatum var. angustatum populations, and future dynamics of these populations. Jones et al. (2019) began developing habitat suitability models for Antioch Dunes eveningprimrose at Antioch Dunes using remote-sensed vegetation metrics (NDVI). It is possible that a continuation of this line of investigation, perhaps including Erysimum capitatum var. angustatum, will lead to improved insights into where and how to develop additional restored sand dunes that will support the recovery of Erysimum capitatum var. angustatum. It may also be useful to consider developing population viability analyses (PVA) that are specifically developed for Erysimum capitatum var. angustatum. For example, it is possible that a stage-structured matrix population model similar to the model developed by Thomson (2005a) for Antioch Dunes evening-primrose could be used to form a foundation for PVA analysis. It is also possible that building and parameterizing such a model, and then projecting this model into various possible futures, including under the influence of changing climate conditions, could help provide insights beyond the PVA's discussed in Service (2019a). As part of efforts to improve statistical analysis and modeling, creating a well-vetted and archived dataset of all Erysimum capitatum var. angustatum surveys, and resolving any discrepancies in counts identified during this review will be critical to progressing on this objective. In late 2019, staff of the Bay-Delta Fish and Wildlife Office met with the staff of the ADNWR and considered convening a recovery implementation team (RIT) for the listed species that occur at the Refuge, including Erysimum capitatum var. angustatum. The primary purpose for convening this group would be to encourage Service biologists, managers and external experts to consider recovery priorities for these species and the Antioch Dunes ecosystem, and continue to stay abreast of emerging research related to Erysimum capitatum var. angustatum and related taxa, riverine dune ecology, and other relevant topics. This group would also help develop a recovery implementation strategy for Antioch Dunes. (USFWS, 2021)

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Antioch Dunes evening-primrose (Oenothera deltoides subsp. howellii)

Contra Costa wallflower (Erysimum capitatum var. angustatum)

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# SPECIES ACCOUNT: *Erysimum menziesii* (Menzies' wallflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A member of the mustard family and a biennial or a short-lived perennial depending on the particular population. Each plant usually has several flowering stems from 0.5 to 1.5 decimeters tall. The flower petals are usually yellow (light or rich yellow), 15-20 mm long. The flowers are grouped into an inflorescence. Fleshy leaves form a basal rosette and are somewhat spoon-shaped, narrowing abruptly to the leaf stalk. Leaf margins are entire, dentate, or lobed. Fruit is a silique, four-sided when green and flattened when dry (Fish and Wildlife Service 1997) (NatureServe, 2015).

**Taxonomy**

Erysimum menziesii is a member of the mustard family (Brassicaceae) (USFWS, 2008). As treated here, following FNA (2010, vol. 7), Erysimum menziesii includes subspecies eurekense, menziesii, and yadonii, but excludes subspecies concinnum. This is the treatment followed by USFWS when the species was listed endangered, Kartesz's 1994 checklist, and the second edition of The Jepson Manual (Baldwin et al. 2012). This treatment is based on Price's 1987 doctoral dissertation. According to FNA, Price's 1993 treatment (followed by Kartesz 1999) accepted four subspecies (concinnum, eurekense, menziesii, and yadonii), three of which were never validly published (NatureServe, 2015).

**Historical Range**

Endemic to California in Monterey, Mendocino, and Humboldt Counties (Fish and Wildlife Service 1997). The range extent is 14,506 sq. km (R. Bittman, pers. comm. 2013) (NatureServe, 2015).

**Current Range**

It is distributed predominately in the nearshore dune community of four disjunct dune systems in northern and central California: Humboldt Bay in Humboldt County, Ten Mile River in Mendocino County, the Marina Dunes at Monterey Bay, and the Monterey Peninsula in Monterey County (Price 1993) (USFWS, 2008).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2008)

**Lifespan**

Adult: 8 years (USFWS, 2008)

**Dependency on Other Individuals or Species**

Adult: Erysimum m. ssp. eurekense: Emphoropsis miserabilis (USFWS, 2008)

**Breeding Season**

Adult: February - April (USFWS, 2008)

**Key Resources Needed for Breeding**

Adult: Fall/early winter rains (USFWS, 2008); insect pollinators (USFWS, 1998)

**Reproduction Narrative**

Adult: Its life history is that of a semelparous (monocarpic) perennial, meaning that it flowers and produces fruit only once during its life, after which it dies (E. m. ssp. yadonii reportedly can flower and fruit twice). The wallflower forms a basal rosette of leaves that may persist for up to 8 years before flowering. Blooming typically occurs from March through April, although it may begin as early as late February. The species is self-compatible; therefore, the reproduction of this species involves selfing and facultative outcrossing (able to produce seed either by self-pollination, or pollination by other plants). Erysimum m. ssp. eurekense is pollinated by a solitary bee species (Emphoropsis miserabilis) in Humboldt County (USFWS 1998). The fruits mature by mid-June. Germination follows the first rains in fall or early winter. Fecundity is high, with individual plants producing numerous seeds; however, the wallflower does not have a persistent seed bank in the soil (Carothers 1996), and seedling survivorship is low, with 98.3 percent mortality shown to occur in the first year (Pickart and Sawyer 1998) (USFWS, 2008). The plant's pollinators are thought to be bees, bumblebees, butterflies, and moths (Price 1986) (USFWS, 1998).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Northern foredune or dune mat community, coastal strand (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: High (inferred from NatureServe, 2015 and USFWS, 1998)

**Habitat Narrative**

Adult: The habitats of the Monterey county populations differ from those of the northern California populations. The plants are generally distributed in clusters or patches. In northern California, the species occurs in northern foredune or dune mat community, on the flanks or crests of dunes, open sand areas, sparsely vegetated dunes, and the borders of lupine scrub. The plants can tolerate some sand movement. The associated vegetation community is composed of low-growing suffrutescent perennial and herbaceous native species. Common associates are beach sagewort (Artemisia pycnocephala), dune goldenrod (Solidago spathulata), coast buckwheat (Eriogonum latifolium), sand verbena, beach pea (Lathyrus littoralis) and seashore bluegrass (Poa douglasii). In Monterey County, the species occurs on coastal strand, close to the high tide line, but largely protected from wave action. The species has high exposure to strong wind, salt spray, and occasional wave action from storms and high tides. The substrate is loose sand lacking in organic matter and minerals. Associated species along the Monterey Peninsula include beach primrose (Camissonia cheiranthifolia), beach-bur, sea rocket (Cakile maritima), beach knotweed (Polugonum paronychia), sand verbena and iceplant. Monterey County habitats are relatively free of the invasive Ammophila arenaria (Fish and Wildlife Service 1997) (NatureServe, 2015). These habitats are not spatially fixed, and are subject to cycles of erosion, deposition, and re-establishment of plant communities over decades (USFWS, 1998).

***Dispersal/Migration***

**Dispersal**

Adult: Low to moderate (USFWS, 1998)

**Dispersal/Migration Narrative**

Adult: The seeds remain attached to the fruit walls after dehiscence and disperse over a long period, primarily in conjunction with winter storm events that dislodge the mature inflorescences and scatter them by way of a wind-driven tumbling action (Pickart and Sawyer 1998) (USFWS, 2008). Most seed dispersal is restricted to the immediate vicinity of the parent plants. Long distance dispersal of seed may occur by fragmentation of seed-bearing branches breaking offend tumbling with the prevailing wind. Isolated individuals of E. menziesii occur on slipfaces of bare, active dunes downwind of vegetated dunes at Ten Mile dunes. This indicates that long-distance seed dispersal may occur where the surface roughness of the dune is minimized (USFWS, 1998).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2008)

**Species Trends:**

30 - 50% decline (NatureServe, 2015)

**Number of Populations:**

16 (USFWS, 2008); 15 (NatureServe, 2015)

**Population Size:**

Unknown (USFWS, 2008); 33,300 (NatureServe, 2015)

**Population Narrative:**

The three subspecies of Erysimum menziesii: ssp. eurekense, ssp. menziesii, and ssp. yadonii, are known from at least 33,300 individuals (Fish and Wildlife Service 1997). Together, the three rare subspecies of Erysimum menziesii, ssp. eurekense, ssp. menziesii, and ssp. yadonii are known from 19 occurrences, 15 of which are presumed to be extant (California Natural Diversity

Database, 2012). Subspecies concinnum is not included here. This species has experienced a short-term decline of 30 - 50% (NatureServe, 2015). Erysimum menziesii is known from at least 16 extant occurrences. With the exception of Erysimum menziesii ssp. eurekense, no statistically valid population estimates have been made of the subspecies of E. menziesii. Therefore, population data are generally inadequate for the purpose of determining trends or assessing response to past management (USFWS, 2008).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Uncontrolled recreational use, such as hang gliders and hikers, continue to impact some populations (Imper pers. obs. 2006). Threats from off-road vehicle use, equestrian use and sand mining remain local threats in some areas. The privately owned occurrences of E. menziesii, particularly in Monterey County, are near expanding urban centers subject to growing demand for recreational opportunities (Imper pers. obs. 2006) (USFWS, 2008).

**Stressor:** Disease and predation (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Deer have significantly impacted a population of E. m. ssp. eurekense on the South Spit of Humboldt Bay (Clifford 2006), and nearly all E. m. ssp. menziesii occurrences on the Monterey Peninsula Disease caused by the crucifer rust (Albugo candida), a pathogenic fungus, affects a significant portion of E. m. ssp. menziesii in Humboldt County (Pickart 2004). An unidentified fungus was also observed affecting Erysimum menziesii ssp. yadonii (Zoger and Pavlik 1987). In E. m. ssp. eurekense, disease symptoms are more prevalent on reproductive individuals, where they can decrease fecundity by reducing seed number or viability (Pickart and Sawyer 1998) (USFWS, 2008).

**Stressor:** Climate change (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. The effects to particular species is unknown at this time (USFWS, 2008).

**Stressor:** Invasive species (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The primary threat to Erysimum menziesii when it was listed, and which continues to be the major threat for most populations is displacement by invasive non-native plant species. In Humboldt County the primary threats are European beachgrass, yellow bush lupine, iceplant, and jubata grass (Cortaderia jubata). European beachgrass and iceplant are the primary threats in Mendocino County, and iceplant in Monterey County. No efforts have yet been made to control or map burclover (Medicago polymorpha), ripgut brome (Bromus rigidus), or other invasive species that may be competing with E. m. ssp. menziesii within MacKerricher State Park.

***Recovery***

**Reclassification Criteria:**
1. Habitat occupied by the three endangered subspecies of Erysimum menziesii needed to allow delisting has been secured, with long-term commitments and, if possible, endowments to fund conservation of the native vegetation (USFWS, 2008).

2. Management measures are being implemented to address the threats of invasive species and other problems, including grazing, pedestrians, and off-road vehicles at some sites (USFWS, 2008).

3. Monitoring reveals that management actions are successful in reducing threats of invasive non-native species (USFWS, 2008).

Additional restored habitat has been secured, with evidence of either natural or artificial long-term establishment of additional populations, and long-term commitments (and endowments where possible) to fund conservation of the native vegetation (USFWS, 2008).

**Delisting Criteria:**
1. Studies have elucidated its life history requirements so that it is possible to predict the responses of populations to management and their viability (USFWS, 2008).

2. The dune systems supporting the 3 subspecies are actively protected from recreational violations, particularly by off-road vehicles (guaranteed funding to enforce ordinances), development, invasive weeds (including European beach grass, iceplant, and yellow bush lupine for subspecies eurekense in Humboldt County and iceplant for the entire species), and predators (deer in Monterey County) (USFWS, 2008).

3. Each occupied dune system has reasonable numbers of plants distributed widely enough to minimize the risk from accidental or catastrophic events. Erysimum menziesii ssp. eurekense (Humboldt Bay dune system) Goals: 3 populations with minimum 300 plants each; 2 populations with minimum 5,000 plants; Erysimum menziesii ssp. menziesii (Ten Mile Dunes system/Monterey Peninsula) Goals: 4 distinct sites and 5 total populations across the range; 3 populations averaging at least 300 plants; 2 populations averaging at least 5,000 plants; Erysimum menziesii ssp. yadonii (Marina dune system) Goals: Taxon to be present throughout its present range from south of Salinas River to Marina Dunes and potentially the Fort Ord area, with 2 populations averaging at least 5,000 individuals, and 3 populations averaging 300 plants or more (USFWS, 2008).

**Recovery Actions:**

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plant (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).
- Completion of population estimates for the Monterey and Mendocino County populations of Erysimum menziesii (USFWS, 2008).
- Establishment of a uniform reporting protocol for agencies conducting population inventories and habitat restoration across the range (USFWS, 2008).
- Increased Service support, in the form of funding and staff involvement, of habitat restoration and population enhancement efforts along the Marina Dunes on private and public lands (USFWS, 2008).
- completion of a Genetics evaluation and taxonomic review of E. menziesii across its range to help resolve outstanding questions on the identity of several large populations (USFWS, 2008).
- Investigation of methods and reliable funding mechanisms for ensuring future invasive species monitoring and control programs at critical sites (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The recommendations in the 2008, 5-Year Review remain our top priorities for the recovery of Menzies' wallflower. These include: 1. completion of population estimates for the Monterey and Mendocino County populations of Menzies' wallflower 2. establishment of a uniform reporting protocol for agencies conducting population inventories and habitat restoration across the range 3. increased USFWS support, in the form of funding and staff involvement, of habitat restoration and population enhancement efforts along the Marina Dunes on private and public lands 4. completion of a genetics evaluation and taxonomic review of Menzies' wallflower across its range to help resolve outstanding questions on the identity of several large populations 5. investigation of methods and reliable funding mechanisms for ensuring future invasive species monitoring and control programs at highly valuable sites (USFWS, 2020)

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# SPECIES ACCOUNT: *Erysimum teretifolium* (Ben Lomond wallflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/07/1994; Pacific Southwest (R8)

**Physical Description**

Ben Lomond wallflower is a short-lived perennial plant, or occasionally an annual. Seedlings form a basal rosette of leaves which then wither as the main stem develops a raceme (flowers clustered in a terminal spike). The flowers are a deep yellow with petals 1 .3—2.5 centimeters (0.5—1.0 inch) long. The fruit, a slender capsule, reaches 10 centimeters (4.0 inches) in length and is covered with three-parted hairs. Characteristics that separate this plant from other wallflowers include simple, narrowly linear leaves that have small marginal teeth and a purplish cast. (USFWS, 1998)

**Taxonomy**

In the mustard family (Brassicaceae). Erysimum teretifolium was first collected at Glenwood, Santa Cruz County by Horace Davis in 1914. This plant was described by Alice Eastwood in 1938 as Erysimum filifolium, not realizing that this combination had already been applied to another plant (Eastwood 1938). Therefore, it was renamed Erysimum teretifolium the following year (Eastwood 1939). (USFWS, 1998)

**Historical Range**

Endemic to Santa Cruz Mtns., Santa Cruz County, California. (USFWS, 2008)

**Current Range**

Endemic to Santa Cruz Mtns., Santa Cruz County, California. (USFWS, 2008). Ben Lomond wallflower (Erysimum teretifolium) occurs within the sandhills of the Santa Cruz Mountains. The central range of the species is generally bounded by the communities of Ben Lomond, Glenwood, Scotts Valley, and Felton in Santa Cruz County (Figure 1). An outlying population is found at Bonney Doon Ecological Reserve approximately 5 miles west of the central concentration of occurrences (USFWS, 2022).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2008)

**Lifespan**

Adult: 1 - 2+ years (inferred from USFWS, 2008)

**Breeding Season**

Adult: March - July (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, heavy fall rains (USFWS, 2008)

**Other Reproductive Information**

Adult: Ben Lomond wallflower is a monocarpic biennial plant that produces leaves but not flowers in the first year after germination. Flowers are typically produced in the second year (less frequently 3 years and rarely 4 years after germination) and die after seed set. Rarely will plants flower in the first year following germination or survive to flower and set seed more than once. In a recent experimental introduction study, approximately 11 percent of seedlings survived to produce an inflorescence in the second year (McGraw et al. 2020, p. 41). Herbivory pressure is high on both vegetative and flowering individuals, reducing the number of plants that set seed (McGraw and Chrislock 2019a, p. 15). Germination and survivorship have been observed to follow annual rainfall patterns, with wetter years having greater germination and survivorship than drought years (McGraw and Jordan 2021, pp. 19-20). Ben Lomond wallflower is largely self-incompatible, needing pollen from flowers not on the same plant in order to produce seed (Melen et al. 2016, p. 1983). Self-pollination sometimes results in fruit development, but the number of seed produced averages 6.5 times less than the amount of seed produced from cross pollination (Melen et al. 2016, p. 1983). Cross pollination between populations produces slightly more seed per fruit than cross pollination within population, suggesting that the small populations may be experiencing inbreeding depression (Melen et al. 2016, p. 1983). Bees, butterflies, and beetles are the most commonly observed floral visitors (Melen et al. 2016, p. 1982-1983). Pollen limitation was evaluated as a potential source of population declines, but manually adding pollen to flowers did not increase seed set, suggesting that populations of Ben Lomond wallflower are not pollen limited (USFWS, 2022).

**Reproduction Narrative**

Adult: Flowers from March to July (NatureServe, 2015). Erysimum teretifolium is a short-lived perennial or sometimes annual plant. This species is self-incompatible, and crosspollination is necessary for fertilization to occur. Chalcedon checkerspot butterflies (Euphydryas chalcedona), ants, European honeybees, and bumble bees have all been seen on the flowers of this species, but the potential for these insects to achieve pollination is unknown (McGraw 2004b). Observations by McGraw (2004b) indicate that the numbers of siliques produced per plant is quite variable (10- 107) and that seed production is positively correlated to silique length (9-15 centimeters produced 5-65 seeds). Seeds germinate after the first heavy rains in the fall, and were found to germinate at least up to 5 years after reaching maturity (McGraw 2004a and McGraw 2004b) (USFWS, 2008).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Ponderosa pine woodland, northern maritime chaparral (NatureServe, 2015); Zayante sandhills (USFWS, 2008)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (USFWS, 2008)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs at 200 - 400 m elevation (NatureServe, 2015); succession (USFWS, 2008)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2008)

**Habitat Narrative**

Adult: Inhabits inland pockets of sandstone-derived coarse sandy soils; these are uplifted ancient marine terraces persisting in a mountain range of volcanic origin. These coarse sands create drier soil conditions than those in the surrounding substrates and support unusual, open, park-like ponderosa pine woodland and northern maritime chaparral communities. The species occurs preferentially in loose, uncompacted sand in openings between scattered chaparral shrubs, at 200 - 400 m elevation (NatureServe, 2015). The Zayante sandhills is a unique habitat type that is comprised of outcrops of sandy soils derived from marine deposits. Suppression of natural fire regimes has led to habitat conversion via the encroachment of woody invasive and native species and invasive annual grasses (Brunette 1997, USFWS 1998). This encroachment has led to conversion of much of the existing open, sandy soil habitat required by E. teretifolium and other shade intolerant sandhills plants, resulting in the establishment of shade-providing species and a build-up of leaf litter. The poor recovery record for sandhills habitat suggests a fragile system where biotic and abiotic factors coevolved in delicate balance over long time periods (USFWS, 2008).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2008)

**Dispersal/Migration Narrative**

Adult: Seeds usually fall directly below the parent plant (USFWS, 2008).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2008)

**Species Trends:**

Declining (USFWS, 2008)

**Number of Populations:**

17 (USFWS, 2008)

**Population Size:**

1,000 - 3,000 (USFWS, 2008)

**Additional Population-level Information:**

Population abundance data are only available for Quail Hollow Quarry Conservation Areas, Zayante Sandhills Conservation Bank, Bonny Doon Ecological Reserve, and Quail Hollow Ranch Park. The remaining locations have no information on abundance and population trends, or have infrequent single year data (Table 1). Data from Quail Hollow Ecological Reserve (also known as Quail Hollow Ranch County Park) between 2012 and 2022 suggest that the population is stable, with reproductive adults ranging between 200 and 400 plants (T. Kasteen 2022, pers. com.). The abundance of adult plants is measured as density and frequency at the Quail Hollow Quarry Conservation Areas and has remained relatively stable, but low, ranging between 1 and 6 plants within 20-meter squared plots between 2006 and 2020 (McGraw and Jordan 2021, p. 42). The number of plants within the Zayante Sandhills Conservation Bank has been historically low because that location captures only a small portion of a larger population that occurs within the Quail Hollow Quarry Conservation Areas. There was only a single adult plant observed in 2015 when annual monitoring began. However, through management and experimental outplanting the number of adult plants increased to 10 in 2021 (McGraw and Chrislock 2021, p. 27). The plants at the Zayante Sandhills Conservation Bank are best viewed as a small portion of a larger population that is increasing due to management efforts. The naturally occurring population at Bonny Doon Ecological Reserve has declined to six naturally occurring adult plants in 2022 (Kasteen 2022, pers. com.). The population has ranged between 1 and 50 adult plants since annual data began being collected in 2005. Experimental reintroductions have also taken place at this location with 837 adult plants observed in reintroduction areas in 2021 but declining to 189 plants in 2022 (Kasteen 2022, pers. com.). Herbivory, invasive species, litter, and drought have been attributed to the decline of the natural population and threaten the persistence of the reintroduction effort (Kasteen 2022, pers. com) (USFWS, 2022).

**Population Narrative:**

There are 17 extant populations. Trends are impossible to determine at many sites since either there are only data from a single survey or no survey data was available. The annual total of individuals over all populations has ranged between 1,000 and 3,000 individuals per year in the most productive recent years. Of the remaining known populations, half are either declining or possibly extirpated (USFWS, 2008).

***Threats and Stressors***

**Stressor:** Sand mining (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current sand mining is still destroying occupied E. teretifolium habitat. Unless new mining operations are proposed, future sand mining will be a reduced threat to the remaining habitat of the species because many of the mining operations are either being closed or are nearing closure (McGraw 2004b; B. Davilla, pers. comm. 2006). A substantial amount of the sandhills habitat had already been destroyed by mining operations prior to the listing of Erysimum teretifolium.

**Stressor:** Development and agriculture (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Urban development is not occurring at as rapid a rate as it was in the past, but the lasting effects of past development remain (e.g., habitat fragmentation, habitat alteration from landscaping). There are several sites that are immediately adjacent to existing homes on private

property that could provide good preservation opportunities. However, even if these areas were preserved, and little to no further development occurred, fragmentation at these sites would remain an issue. There is some grape production in the Bonny Doon area for winemaking purposes. Recent aerial photos do indicate the existence of exposed sandy soils in the area that may provide suitable habitat; however, private ownership of most of the surrounding properties has precluded any recent surveys of the area for Erysimum teretifolium. Additionally, signs posted in fallow vineyard areas indicate the application of insecticides and/or herbicides to the soil (C. West, pers. obs. 2007). Effects of these applications directly on E. teretifolium or on its pollinators are unknown (USFWS, 2008).

**Stressor:** Recreation (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At this time, recreational use continues to threaten some populations of Erysimum teretifolium. Fences are often cut and neighboring equestrians use the area, resulting in large quantities of erosion (J. McGraw, pers. comm. 2006; C. West, pers. obs. 2007). Another population (EO #14) on private land also shows much erosion due to recreation. This site is visible from nearby public land and supports some large specimens of E. teretifolium (C. West, pers. obs. 2007). Although there are “no trespassing” signs in place and wire fencing, there is extensive erosion, apparently from sandboarding (C. West, pers. obs. 2007). The effects of recreational activities are also apparent at the South Ridge site in Quail Hollow Quarry (former EO #1). Recreational activity at this site seems to be limited to hikers and dog-walkers accessing areas on foot, despite fencing and signage (C. West, pers. obs. 2007) (USFWS, 2008).

**Stressor:** Herbivory (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Observations of herbivory and potential effects at the population level have been noted by researchers (Brunette 1997, McGraw 2004b). Pocket gophers (Thomomys bottae) have been shown to consume up to 8 percent of rosettes prior to seed set in monitored populations (McGraw 2004b). Observations indicate that up to 37 percent of adult plants may be browsed by mule deer (Odecoileus hemionus), which greatly increases the likelihood of those plants dying without successfully reproducing (J. McGraw, pers. comm. 2007a) (USFWS, 2008).

**Stressor:** Fire suppression and succession (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sandhills communities are fire-adapted, and fire plays a major role in resetting soil succession (McGraw 2004b). Fire has also been shown to play a role in the reduction of invasive non-native species in the sandhills parkland and chaparral habitat types (McGraw 2004b). Not only does suppression of fire directly leave leaf litter in place to accumulate, but McGraw (2004a) found that nonnative species prevented sloughing of this litter that otherwise occurs easily during rain and wind events from the bare sandy soil. Even with litter removal via manual methods such as raking, McGraw (2004a) found that the remaining non-native plants reduced soil moisture content, causing an increased risk of desiccation in E. teretifolium seedlings. At the

time of listing, vegetation succession leading to increased canopy density due to fire suppression was considered a threat to Erysimum teretifolium, which is relatively intolerant of shade. Perhaps more importantly, the habitat conversion leading to this increased canopy density will eventually result in a habitat type which cannot support many of the open sand specialists unique to sandhills parkland (McGraw 2004b, P. Levine, pers. comm. 2006). Many areas where E. teretifolium formerly occurred have undergone extensive habitat conversion; in several of these areas, it is doubtful whether the open sandy soil required by this species still exists (USFWS, 2008).

**Stressor:** Stochastic events (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** With increased successional pressures due to fire suppression, encroachment by nonnative plants, and human development, sandhills “islands” have shrunk in size and become even more fragmented (McGraw 2004b). Because seed dispersal distance is limited in Erysimum teretifolium (seeds usually fall directly below the parent plant), fragmented populations are likely to remain isolated. Of the populations surveyed in recent years, most have had very low numbers of individuals, and many had no individuals present. As habitat conversion increases due to various factors and remaining habitat is further fragmented and reduced in size, populations will continue to shrink and the risk of stochastic extinctions will increase (USFWS, 2008).

**Stressor:** Invasive Species (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive species outcompete Ben Lomond wallflower by decreasing the amount and size of vegetation gaps within sand chaparral and sand parkland habitat, as well as through shading and competition for nutrients and water (McGraw 2004, pp. 240-244, 253-254). Invasive species that have established within former sand quarries are difficult to control, making reintroduction and recovery of Ben Lomond wallflower at those sites difficult. Portuguese broom (Cytisus striatus), French broom (Genista monspessulana), and silver wattle (Acacia dealbata) are three common woody invasive species that have been observed to establish rapidly in areas with low levels of disturbance (BEC 2021a, p. 6; BEC 2021b, p. 4; McGraw and Chrislock 2022, p. 4)). Once established, these and related species require annual removal efforts. Sand chaparral and sand parkland soil is typically low nutrient, which may inhibit invasive herbaceous species colonization. Pollution may increase nitrogen deposition and increase the fertility of the nutrient-poor soils, facilitating the potential establishment of invasive species (McGraw 2019a, p. 39). Herbaceous exotic species such as rat-tail fescue, rip-gut brome, rattlesnake grass, smooth cat’s ears, and sheep sorrel already constitute a major component of sand parkland habitat. These species are in lower densities in sand chaparral habitat (McGraw 2019a, pp. 7, 10-19). Complete removal of herbaceous exotic species is difficult due to established seed banks and presence in surrounding areas facilitating passive dispersal. Where herbaceous invasive species are limiting Ben Lomond wallflower presence continued active management will be required for recovery (USFWS, 2022)

***Recovery***

**Reclassification Criteria:**
1. The 17 currently known populations have been secured through fee-title acquisition, conservation easements, or Habitat Conservation Plans. (USFWS, 1998)

2. Management plans for populations on Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve are developed and being implemented. (USFWS, 1998)

3. Management plans for populations on Quail Hollow Ranch County Park and the adjacent State-owned parcel, Bonny Doon Ecological Reserve, Henry Cowell Redwoods State Park, Big Basin State Park, and Gray Whale Ranch State Park are developed and being implemented.

4. Population numbers are stable or increasing. (USFWS, 1998)

Recovery Priority Number: 5

**Delisting Criteria:**
When the downlisting criteria have been met for a species the species can be considered for delisting if: 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. (USFWS, 1998)

**Recovery Actions:**
- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history. ecology, and population dynamics of these species that will contribute to appropriate management strategies Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa

Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)

- 6. Evaluate progress of recovery effectiveness of management and recoverv actions and revise management plans. (USFWS, 1998)
- Recommended Action from 2008 5-Year Review: Surveys and monitoring should be undertaken for all known populations and potential habitat to ensure that potential populations are identified and reliable demographic information is collected. Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted and permission should be secured to survey these private holdings where necessary. Specifically, all populations listed in the CNDDB and McGraw (2004b) should be surveyed to focus future recovery efforts, especially the areas between and surrounding Vista Robles Drive and Marion Avenue in Ben Lomond and the area around the intersection of Pine Flat Road and Bonny Doon Road in Bonny Doon. In addition, coordination of recovery partners and consolidation of population data into the CNDDB records should be undertaken. Additionally, survey methods should be standardized to insure data accuracy. Methods employed by Brunette (1997) may be suitable for this purpose (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: Expand research efforts focusing on potential causes of reproductive failures and methods to increase reproductive success as mentioned in the “Needed Recovery Actions” section of the recovery plan. As part of these efforts, the effects of predation on the species should be examined and pollination mechanisms should be identified. With clarification of such processes, management of landscape level influences on the species may be undertaken, such as predatory deterrence and management of potential pollinator barriers. Such research may contribute greatly in the form of increased survival, boosting reproductive success, and maintaining interfragment pollination to maximize gene flow, thereby avoiding inbreeding depression (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: More detailed knowledge of populations and completion of management plans should allow active management to prevent encroachment of both native and non-native species in fire-suppressed areas, which threaten type conversion of the habitat and potential extirpation of individual populations. Prescribed burns mimicking natural fire cycles would be the most effective way to thin vegetation and restore open habitat; however, in many areas the proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion (McGraw 2004a and McGraw 2004b). Effectiveness of this method to improve Erysimum teretifolium habitat and increase reproductive success is being examined at Bonny Doon Ecological Reserve. If these studies prove effective, this method should be initiated in occupied habitat where fire would create unacceptable risk to local communities. Outreach to local landowners in such areas may facilitate the implementation of such management strategies over larger, contiguous pieces of occupied habitat and thereby maximize the conservation potential of all remaining populations. Such vegetation clearing efforts should be approached from a fuels reduction angle, which further benefits all parties involved (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: Increased USFWS oversight as time allows may accelerate completion of the draft HCP with the County of Santa Cruz and other management plans under development. These plans need to be completed to help guide implementation of effective recovery efforts (USFWS, 2008).

- Recommended Action from 2008 5-Year Review: We suggest the USFWS consider revising the third criterion for downlisting in the recovery plan. This criterion lists specific HCPs by name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time. Such changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criteria should be avoided. A blanket statement reflecting the need to include the species in any HCP that covers its occupied range would be more appropriate (USFWS, 2008).

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# SPECIES ACCOUNT: *Euphorbia telephioides* (Telephus spurge)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 6/8/1992; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Euphorbia telephicides is a perennial herb with a stout storage root. Stems are numerous, giving the plant a bushy appearance, and are up to 30 cm (1 ft)2 tall. Stems and leaves are smooth and have latex (milky sap). The largest leaves are 3-6 cm (1-2 in) long, elliptic or oblanceolate, with the midrib and margins usually maroon. The inflorescence is a cyathium (a structure resembling a flower, containing a single stalked female flower and several male flowers, each reduced to a single stamen). flowering is from April through July (Kral 1983). Clewell (1985) and Kral (1983) provide guidance for distinguishing this species from the most similar species, Euphorbia inundata, a taller plant of moister habitats. (USFWS, 1994)

**Taxonomy**

Euphorbia telephioides is a member of the spurge family (Euphorbiaceae). It was named by Alvin Wentworth Chapman (1860), who provided no explanation for his choice of name, but rather clearly intended to indicate a resemblance to another plant, most likely the garden plant Sedum telephium (orpine, live-forever, or stonecrop) or the similar North American Sedum telephioides. Small (1933) preferred to split the huge genus Euphorbia into smaller genera, renaming this species Galarhoeus telephioides. Taxonomists since then have left the genus Euphorbia intact. Webster (1967) established a new subsection of the genus Euphorbia, Inundatae, that includes Euphorbia telephioides and two other species native to the Florida panhandle: Euphorbia floridana and E. inundata (USFWS, 1994).

**Historical Range**

Endemic to the Florida panhandle and restricted to Bay, Gulf, and Franklin counties. It is unknown whether E. telephioides was once continuously distributed throughout the three counties or populations were restricted to local habitat patches (USFWS, 2015).

**Current Range**

Currently known from Bay, Gulf, and Franklin counties from Panama City Beach to east of Apalachicola (USFWS, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (NatureServe, 2015)

**Breeding Season**

Adult: April - July (USFWS, 1994)

**Reproduction Narrative**

Adult: Several staminate flowers surrounding a pistillate flower in a cyathium (Gleason, 1952). The species is monoecious and reproduction is sexual (NatureServe, 2015). Flowering is from April through July (Kral 1983) (USFWS, 1994).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015); wetland (USFWS, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Longleaf pine-slash pine savanna/flatwoods (NatureServe, 2015); coastal pinelands (USFWS, 1994)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Excessive shade, development (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Wiregrass dominated, longleaf pine-slash pine savanna/flatwoods or on contiguous low, sandy rises dominated by pine-scrub oak near the coast. Cannot tolerate shade, needs fire to maintain community structure; can survive initial conversion of flatwoods to pine plantation. Separation barriers are created by clearing and development of habitat; fire-suppressed scrub and flatwoods (NatureServe, 2015). Although uncommon, telephus spurge was observed growing in wetlands with seepage slope species and in small thick clumps of wire grass surrounded by pine or cypress (Rountree et al. 2005). In general, the plants do well on sandy, acidic soil, with no litter, and low organic and moisture content (Peterson & Campbell 2007) (USFWS, 2015). Inhabits poorly-drained coastal pinelands (USFWS, 1994).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2015)

**Dispersal/Migration Narrative**

Adult: Seeds are not dispersed over large distances (Negrón-Ortiz, 2014, pers. observ.) (USFWS, 2015).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Stable (USFWS, 2015)

**Number of Populations:**
42 (USFWS, 2021)

**Population Size:**
>20,000 individuals

**Population Narrative:**
The species status is stable; seven populations are properly protected; three new occurrences were documented; recent surveys conducted on several sites found the species in excellent condition. The number of populations has increased to 41 sites based on recent survey work (FNAI 2007; 2013 -2014 FWS surveys; consultation surveys). Trapnell et al. (2012) found species-wide genetic diversity was high, ranking E. telephioides among the highest 10% of plant species surveyed. However, genetic differentiation among populations is lower than that observed for other herbaceous outcrossing perennial plant species (USFWS, 2015).

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Urban development continues to threaten telephus spurge since most E. telephioides documented locations are found in private land. 380,000 acres of land will maintain timber and agriculture uses, included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Many E. telephioides' locations are found along US 98, and powerline ROW maintenance (removal of existing and installation of new transmission poles), road widening and new roads continue to negatively affect plant abundance and habitat loss. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million. Suppression of fire during the dormant season continues to threaten the pineland and savanna's flora as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity (USFWS, 2015).

**Stressor:** Sea level rise (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter (m) above current sea level. Wolf and Lopez (2014) estimated the potential for inundation of habitat areas for the Telephus spurge at sea level rise projections from 0.305 to 1.83 m (one to six feet) within this century. The projections indicated that coastal habitat areas in Escambia, Bay, Franklin, and Gulf Counties would be largely inundated beginning at 0.305 m (one foot) of SLR. Therefore, SLR projections of changes, under above all scenarios, will most likely

affect several coastal populations specifically those located in Gulf and Franklin counties. Euphorbia telephioides is at risk of further decline from SLR because its seeds are not dispersed over large distances (Negrón-Ortiz, 2014, pers. observ.), so sea level may rise more quickly than the species can establish populations further inland. In addition, E. telephioides does not respond well to transplantation (Ecological Resource Consultants 2006; Negrón-Ortiz, 2010, pers. observ.). Another major concern is that as more coastline is inundated with water, urban development will expand, decreasing the amount of suitable habitat for E. telephioides and impeding the ability of these species to move landward (USFWS, 2015).

***Recovery***

**Reclassification Criteria:**
Not defined (USFWS, 1994; USFWS, 2015)

Recovery Priority Number: 2C

**Delisting Criteria:**
1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery (USFWS, 1994; USFWS, 2015).

**Recovery Actions:**

- Protect populations in Apalachicola National Forest and on other public lands. This includes Management/general monitoring in Apalachicola National Forest, Conduct of population biology studies, and Conduct of botanical inventories on public land, possible purchase areas, and selected private land. (USFWS, 2015)
- Manage rights-of-way. Highway and utility rights-of-way (mostly electric powerlines along highways) harbor populations of all four plant species. Experience with managing Harperocallis flava (Harper's beauty), an endangered plant, on a highway right-of-way in Apalachicola National Forest may suggest approaches for conserving these species. (USFWS, 2015)
- Protect and manage populations outside Apalachicola National Forest through purchase, conservation easements, or other means; develop conservation plans for these sites (USFWS, 2015).
- Conduct systematic and other studies; arrange reintroduction where appropriate and feasible (USFWS, 1994).
- Garden propagation and reintroduction. Reintroduction of Euphorbia telephioides depends on suitable, protected habitat being available and methods being developed. It is not yet clear whether it would be useful to maintain garden populations of this species. (USFWS, 2015)
- Establish monitoring program: i. Identify additional populations of conservation importance based on information from the genetic studies (ongoing). ii. Conduct a demographic population viability analysis to assess whether the species is declining, increasing, or stable, and where in the life cycle the management should be targeted. This is an ongoing action conducted by Ms. Natali Miller, a graduate student from FL State University (USFWS, 2015).
- Collect voucher specimens (e.g., herbarium specimens, samples for DNA analyses, preserve material, seeds and whole plants) from areas proposed to be developed and 1) transplant to

suitable sites, and 2) distribute to herbaria, botanical gardens, and interested scientists (USFWS, 2015).

- Expand germination studies. i. Determine seasonal fluctuations that influence germination timing and recruitment and identify traits that correlate with seed viability and dormancy ii. Conduct ex situ germination studies and clarify limits of seed desiccation and cold tolerance (USFWS, 2015).
- Develop a Species Distribution Model (SDM) to assist with locating new populations and identifying prospective sites for reintroductions such as areas that will not be affected by SLR and future development. Sites should be validated or inspected for plants, and then protected by land acquisitions, conservation easements. This is an ongoing action conducted by Ms. Alexa Mainella, a graduate student from Miami University, OH (USFWS, 2015).
- Phenological data (timing, duration and abundance of recurrent biological processes, including reproductive events such as flowering, fruiting, seed dispersal and germination) have emerged as useful tools for studying the impact of climate change on plants. Lacking phenological adaptability may require a stronger signal or may be unable to adapt to climate warming, and therefore may experience greater stress or even extinction during extended climate change. Therefore, phenological studies should include both long-term observations coupled with herbarium specimens' records (USFWS, 2015).
- Since E. telephioides occurs in fire prone habitats, the effect of this disturbance on survival and fecundity should be monitored to determine the best frequent fire regimes, on selected areas to maintain optimal conditions of E. telephioides populations (USFWS, 2015).
- Continue fostering a working partnership with the St. Joe Company, AgReserves, Inc. and other developing companies and consulting agencies, such as Flatwoods Consulting Group to address and minimize potential impacts associated with development and fire suppression (USFWS, 2015).
- Outreach: Promote the implementation of the recovery actions via academia, private landowners, and public agencies. Develop and distribute information to the general public (USFWS, 2015).
- The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2015).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Establish monitoring program i. Conduct a demographic population viability analysis to assess whether the targeted populations are projected to decline, increase, or remain stable, and where in the life cycle the management should be targeted. This is an ongoing action conducted by Ms. Natali Ramirez-Bullon, a graduate student from FL State University. Projected completion late 2021. She constructed and analyzed stage-structured stochastic demographic models for three E. telephioides populations to answer the projected growth rate of each population, and whether incorporation of a larger sample alters the projected growth rate. Overall, the models suggested a decline over the next 100 years. ii. Identify additional populations of conservation importance based on information from the genetic studies (ongoing). a. Collect seeds targeting all E. telephioides sexual morphs for ex-situ seed conservation -ongoing and conducted by the ABG b. Establish permanent plots on at least three additional protected locations throughout the species' historical range. For each plot: a. Estimate the sex ratio, density, and abundance of individuals. b. If possible, investigate basic ecological questions (e.g., pollinators; flowering period; annual variability in flowering; seed production and seedling survival). c. Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure. 2. Collect voucher specimens (e.g., herbarium specimens, samples for DNA analyses, preserve material, seeds and whole plants) from areas proposed to be developed and 1) distribute to herbaria, botanical gardens, and interested scientists, and 2) relocate to suitable sites with appropriate tools and best management (e.g., avoid transplant shock and high temperatures, and whether dormant plants are the optimal stage for relocation). For details see Negrón-Ortiz & Kaeser (2020). i. Knowledge of this species' sexual expression is necessary during plant rescue and the establishment of new populations. For establishment, all E. telephioides sexual morphs should be represented. ii. If seeds are collected for establishment or ex-situ approaches, a large number may be required to overcome low germination and seedling establishment, and the unpredictability of the sex ratio. 3. Develop a Species Distribution Model (SDM) to assist with locating new populations and identifying prospective sites for reintroductions such as areas that will not be affected by SLR and future development. Sites should be validated or inspected for plants, and then protected by land acquisitions, conservation easements. This is an ongoing action, see Appendix 1, recovery criterion 4. 4. Expand germination and seedling survivorship studies. i. Determine seasonal fluctuations that influence germination timing and recruitment and identify traits that correlate with seed viability and dormancy ii. Conduct ex situ germination studies and clarify limits of seed desiccation and cold tolerance. This is an ongoing action conducted by the ABG for 2021-2023 iii. Look at historical data, such as herbarium specimens recorded observations, to understand what abiotic and biotic factors influenced germination timing and recruitment in the past. Note: Atlanta Botanical Garden planned to collect seeds from known and any discovered populations (based on SDM, action 3) to conduct germination and viability studies, establish collections in their Conservation Seed Bank, and for propagation for use in reintroduction experiments within protected lands where suitable habitat is found (ongoing action 2021-2023); funds were obtained from the Coastal Program. iv. Further investigate in-situ seedling survivorship and growth across years to help to understand E. telephioides population persistence (see NegronOrtiz & Kaeser 2020) 5. Phenological data (timing, duration and abundance of recurrent biological processes, including reproductive events such as flowering, fruiting, seed dispersal and germination) have emerged as useful tools for studying the impact of climate change on plants. Lacking phenological adaptability may require a stronger signal or may be unable to adapt to climate warming, and therefore may experience greater stress or even extinction during extended climate change. Therefore, phenological studies should include both long-term observations coupled with herbarium specimens' records. Complete for long-term in-situ observations (Negron-Ortiz & Kaeser 2020); Not initiated: document phenology using herbarium specimens' records. 6. Since E. telephioides occurs in fire prone habitats, the effect of this disturbance on survival and fecundity should be monitored to determine the most appropriate fire return intervals, on selected areas to maintain suitable habitat conditions of E. telephioides populations. Complete for the effect of this disturbance on survival and fecundity (Negron-Ortiz & Kaeser 2020); partially complete/understood: determining the appropriate fire return intervals. 7. Euphorbia telephioides changes in sex expression occurred in response to factors such as temperature, specifically after fire (Negron-Ortiz & Kaeser 2020). The impact of elevated temperatures (and photoperiod) on changes in sex expression should be further investigated as it can provide insights into the performance of this species under the impacts of frequent disturbance and climate change. i. The long-term effect of temperature on tagged individuals can be measured by establishing permanent monitoring plots across the entire range of E. telephioides at sites maintained with prescribed fire. 8. Continue fostering a working partnership with the St. Joe Company, AgReserves, Inc. and other developing companies and consulting agencies, such as Flatwoods Consulting Group to address and minimize potential impacts associated with development and fire suppression. 9. Outreach: Promote the implementation of the recovery actions via academia, private landowners, and public agencies. Develop and distribute information to the general public. This is an ongoing action, see Appendix 1, recovery criterion 4. (USFWS, 2021)

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# SPECIES ACCOUNT: *Galactia smallii* (Small's milkpea)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/19/1985; Southeast Region (R4)

**Physical Description**

Galactia smallii is a small, trifoliolate, perennial legume with small, purple flowers and a prostrate habit. The stems are grayish, due to a covering of short hairs, and grow up to 2 m long. The stem internodes are well-developed and have long, straight, soft hairs. The 1 to 2.2 cm long leaflets are broadly ovate to elliptic. The undersides of the leaves have long, soft, wavy hairs lying almost flat against the surface. The upper surface of the leaves are either hairless (glabrate) or have sparse, stiff hairs, lying flat on the surface (strigose). The inflorescences are 2 to 6 cm long with one to five flowers at the apex or along the axis. The flower buds are 5 to 7 mm long, and the calyx is about 7 mm long and loosely strigulose. The corolla is 11 to 12 mm long and pinkish purple or lavender. The legume is 3 to 4 cm by about 4 m in size and is strigulose or villosulous (Isley 1990). (USFWS, 1999)

**Taxonomy**

Small's milkpea was originally described as G. prostrata by Small in 1933. However, H.J. Rogers (unpublished dissertation, Duke University, 1949) discovered that this name is a homonym, unavailable for use, and suggested G. smallii. Since Rogers' proposal was never published, the incorrect name persisted. Herndon (1981) published Rogers' finding and proposed the name change to G. smallii. (USFWS, 1999)

**Historical Range**

The historic range of Small's milkpea is not well known. When this species was listed, it was known from two sites near Homestead in Miami-Dade County. (USFWS, 2010)

**Current Range**

Miami-Dade County, Florida, in a narrow region across a 6.5-mile area, and the Homestead Air Reserve Base (USFWS, 2019).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Small's milkpea is a perennial legume that usually flowers during the summer months. However, numerous flowers may occur following a burn at anytime throughout the year (Small 1933, and Long and Lakela 1971). Fire may synchronize and intensify flowering of plants in the burned area (A. Herndon, personal communication 1998). Its pollinators include three species of bees, one species of wasp, and the Cassius blue butterfly (Leptotes cassius theonus). (USFWS, 1999)

**Habitat Type**

Adult: Pine rocklands/rockland hammocks (USFWS, 1999)

**Environmental Specificity**

Adult: Very Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Preliminary results of a study of the abundance, distribution, and habitat preferences of Galactia species in Miami-Dade County pine rocklands indicate that G. smallii prefers higher elevations and lower shrub cover than the more common Galactia species (O'Brien 1994). The distribution of G. smallii is correlated with soil depth and color in Redland pine rocklands. It does not occur in sites with a high amount of exotic plant cover, specifically, Schinus terebinthifolius and Neyraudia reynaudiana (O'Brien and Koptur 1995). (USFWS, 1999)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

24 sites (USFWS, 2019)

**Population Size:**

~120,000 (USFWS, 2019)

**Population Narrative:**

Galactia smallii is only known from the pine rocklands of Miami-Dade County. The remaining G. smallii populations occur entirely within a narrow region of pine rockland fragments that includes 24 sites – 8 public and 16 private (Bradley, 2010b; Lange, pers. comm. 2017; Possley, pers. comm. 2017) across a 6.5-mile (10.5 km) area within Miami-Dade County. However, a single population at Homestead Air Reserve Base (HARB), contains up to 100,000 individuals (Bradley 2009). Miami-Dade County owns seven of the public sites, purchased for conservation purposes, and is working to restore and manage these lands through their Environmentally Endangered Lands (EEL) program. The final public site, HARB, is seeking to develop their lands, however, they are also coordinating with the Service and IRC to retain and manage the population at this site. G. smallii populations on the 16 private sites range in size from 3 to 1,000 individuals per site (Bradley, 2010b; Lange, pers. comm. 2017; Possley, pers. comm. 2017a). (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat loss and fragmentation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside

of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

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

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

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

***Recovery***

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

Recovery Priority Number: 5C

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

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

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

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

**Recovery Actions:**
- Conduct surveys to determine distribution of pine rockland plants. Pine rockland plants have been thoroughly surveyed in Miami-Dade County. However, other populations may be noted during acquisition and restoration program implementation. Fire may eliminate litter concealing listed species, or enable seeds in the seed bank to germinate. For that reason, pine rocklands that did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of pine rockland plants that populations not be lost. (USFWS, 1999)
- Conduct research on the biology of G. smallii. Additional information on the ecology and life history of pine rockland plants needs to be collected. Determine size and viability of all populations. Known populations of the listed pine rockland plants should be evaluated. Population viability needs to be investigated and determined for each listed plant species. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring needs to be developed for listed pine rockland species in order to determine the effect of management actions on these species. Use existing standardized monitoring protocols developed by the Florida Natural Areas Inventory to record baseline data regarding the biology and ecology of G. smallii. Initiate quarterly monitoring program. (USFWS, 1999)
- Continue to provide public information about pine rocklands and their unique flora. Public support will increase the chances of recovery for these species. Informational and educational materials have been produced. DERM and Miami-Dade County Natural Areas Management have developed flyers, displays, newsletters, and press releases, and have held workshops with the general public. Organizations best able to carry out information and education programs include: Miami-Dade County Parks and Recreation Department, the Florida Native Plant Society, Everglades NP, and Miami-Dade County DERM. Support of local press coverage should continue. DERM has developed a web page that will also aid in disseminating information about this endangered plant community to the public. (USFWS, 1999)

- Habitat-level Recovery Actions: Continue to protect and prevent degradation of pine rockland plant habitat. Restore areas to suitable habitat. Continue to investigate and refine the habitat needs of each species. Monitor habitat and ecological processes. Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. (USFWS, 1999)

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# SPECIES ACCOUNT: *Geocarpon minimum* (No common name)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 6/16/1987; Southeast Region (R4) (USFWS, 2017)

**Physical Description**

A small (1-4 cm tall), ephemeral, succulent winter annual that usually completes its life cycle within a 4-week period in the spring. Young plants are grayish; mature plants reddish-purple. Flowers are inconspicuous. This unusual species comprises the monotypic genus Geocarpon (NatureServe, 2015).

**Taxonomy**

Kartesz & Kartesz (1980) had placed this genus in Aizoaceae but Kartesz (1994 checklist) subsequently placed it in Caryophyllaceae (NatureServe, 2015).

**Historical Range**

Historically found in St. Clair & Jasper Counties, Missouri (NatureServe, 2015).

**Current Range**

Found in southwestern Missouri (Dade, Polk, Greene, and Lawrence Counties). Found in three southeastern counties in Arkansas (Cleveland, Drew, and Bradley) and one Northwestern County (Franklin). Also found at two locations in Louisiana (Wynn Parish). This species was discovered in Texas in 2004 in Anderson County (Keith et al. 2004) (NatureServe, 2015). The range of Geocarpon has been extended farther west within the Arkansas River Valley and the habitat at this site appears similar to that described for the other known site within this region (Baker and Witsell 2015) (USFWS, 2016).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from NatureServe, 2015)

**Lifespan**

Adult: 4 - 6 weeks (NatureServe, 2015)

**Breeding Season**

Adult: February - June (USFWS, 2016)

**Key Resources Needed for Breeding**

Adult: Spring temperature and moisture patterns, possibly centipede pollinators (NatureServe, 2015)

**Reproduction Narrative**

Adult: Geocarpon minimum has been variously described as an annual (Tucker 1983, Palmer and Steyermark 1950) and as a winter annual (Mackenzie 1914, Bridges 1986, Morgan 1986), and this question has not been fully resolved to date. The timing of emergence in the spring can vary widely from year to year with temperature having the greatest influence on initiation of growth. Winter rosettes at Bona Glade begin producing flowering stems anywhere from March to mid April (Morgan 1986). Tucker (1983) lists March 23 to April 23 as flowering dates for Geocarpon in Arkansas; however, following a warm winter, Bridges (1986) found plants on the Warren Prairie site producing stems in late January, flowering by mid-February, and dead or dying by April 1. Although the initiation of growth in the spring is controlled by temperature, Morgan (1986) suggests that the vigor of plants and the number of flowers and seeds produced is probably dependent on soil moisture and temperature conditions experienced after the initiation of growth in the spring. Tucker (1983) states that the life cycle of individual plants is completed in a four week period, and Morgan (1986) indicates that a period of 4-6 weeks passes from the initiation of growth in spring to senescence. To date, no insect pollinators have been observed; however, Shephard (pers. comm.) has observed numerous small centipedes within Geocarpon populations and suggests that they be considered as possible pollinators. Flower production varies from plant to plant with some plants producing 5-7 stems with 2-4 flowers per stem and other plants being single stemmed with only 1-2 flowers produced (Morgan 1986). Shephard (pers. comm.) observed that even in apparently good years, a high percentage (ca. 90%) of the plants produced on the Warren Prairie site were one stemmed, one flowered individuals. Morgan (1986) collected 16 capsules and found from 9 to 72 seeds produced per capsule with a mean of 27 seeds per capsule. Groups of seedlings have been observed growing from capsules produced the previous season (Morgan 1986). Although it is apparent that seeds do survive in seed banks since plants are produced in years following poor seed production, little is known about seed viability and longevity. Tucker (1983) suggests that slight disturbance of the soil surface is necessary for Geocarpon seed germination and seedling establishment. This annual species is also known to have good seed set, with lots of capsules (pers. comm. E. Keith) (NatureServe, 2015). The flowering and fruiting period when the plant is usually most visible ranges from late February to early June (Bates 1994; McInnis and Larke 1997; Smith in litt. 1998; MDC 2000; TNC 2004, 2005) (USFWS, 2016).

**Habitat Type**

Adult: Terrestrial, palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Sandstone glades, saline prairie, riparian (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits sandstone glades and saline prairies. In Missouri, Geocarpon grows on moist, sandy soils on exposed sandstone outcrops or glades, where ledges of fine sandstone, interbedded with shale, are exposed along small streams. The surrounding area, where deeper soils prevail, is savannah. Sites in Arkansas and Louisiana are characterized by very thin soils that are high in sodium and magnesium. Woody plants are nearly absent. In these saline prairies, the species occurs mostly in very thinly vegetated, barren-like areas. The presence of high concentrations of magnesium in the soil may be a critical factor in Geocarpon distribution, since the soils of Geocarpon sites in Arkansas are characteristically high in magnesium and/or sodium. All of the Geocarpon sites currently known from Arkansas occur on saline soil prairies on natric or saline soils. Geocarpon is very sensitive to competition from other species of vascular plants and occurs only in very open areas. The environmental specificity of this species is very narrow as it is a specialist only growing in salt prairies of one kind (NatureServe, 2015).

***Dispersal/Migration***

**Dispersal**

Adult: Low (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Seeds remain in dead capsules and are most likely dispersed near the parent plant by wind or rain or by plants simply falling over). Results of monitoring in Missouri (Morgan 1986) and Arkansas (Shephard 1987) indicate that Geocarpon appears in the same areas from year to year and has low vagility. Tucker (1983) suggests that ants be considered as a possible secondary dispersal mechanism since ant mounds are often found in the vicinity of Geocarpon populations in Arkansas (NatureServe, 2015).

***Population Information and Trends***

**Population Trends:**

Decline of <30% to increase of 25% (NatureServe, 2015)

**Species Trends:**

Stable (USFWS, 2009)

**Number of Populations:**

40 (USFWS, 2016)

**Population Size:**

2500 - 100,000 individuals (NatureServe, 2015)

**Adaptability:**

High (inferred from NatureServe, 2015)

**Population Narrative:**

Survives fairly harsh environmental conditions. Although the long term trend of this species isn't documented, it is suspected that is has been stable (pers. comm. E. Keith). This species has experienced a long-term decline of <30% to increase of 25%. As with many annual species, the size of Geocarpon populations varies greatly from year to year. Shephard (1987) indicates that 2033 plants were found within plots in 1986 (Warren Prairie, Arkansas) and 6761 plants were found within the same plots in 1987. Similarly, Morgan (1986) found 1900 plants in plots (Bona Glade, Missouri) in 1984 and 4055 plant present in the same plots 1986. There are at least 13 occurrences with good viability (NatureServe, 2015). Population surveys indicate that the species status is stable. Populations are currently documented to occur at a total of 37 sites (including three plantings in Missouri) within 17 counties in four states (Osborne in litt. 2005;

Smith in litt. 2006a, 2006c; Reid in litt. 2009; Singhurst in litt. 2009) (USFWS, 2009). Populations are currently documented to occur at a total of 40 sites (including three plantings in Missouri) within 19 counties in four states (Baker in litt. 2015; Baker and Witsell 2015; Briggler in litt. 2015; Reid in litt. 2015; Singhurst in litt. 2015) (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat continues to be soil development on suitable sites within saline prairies (slick spots) and sandstone glades (shallow sandy soils) (Logan 1998; Witsell 2004a; Smith and Ely 2006). Geocarpon thrives in these harsh conditions that exclude competing plant species. Accumulation of more suitable soils quickly leads to an invasion of other plants that shade Geocarpon. Such soil development may be facilitated by lack of disturbances such as fire and use by large mammals (Witsell 2004a; Smith and Ely 2006). Excessive soil development and subsequent colonization by competitive plants may also occur when excessive soil movement occurs due to dense cattle use, ATV use, or other factors. Movement of dirt can also alter the microhydrology of sites which may lead to localized extirpation of subpopulations (TNC 2004; Witsell pers. comm. 2006) (USFWS, 2009).

**Stressor:** Small, isolated populations (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Geocarpon is vulnerable to local extirpations because it occurs in isolated populations and depends on the presence of specific microhabitats in order to compete with other plants. Although extirpations of subpopulations due to encroachment of other vegetation have been observed (Witsell 2004), no known populations have disappeared due to this factor (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change may affect Geocarpon, although the exact mechanisms and whether these effects will be negative or positive is unknown. Some authors have suggested that plant diversity, species phenology and distribution, and increases in extinction risk are all potential outcomes of climate change (Iverson and Prasad 2002; Bertin 2008; and Maclean and Wilson 2011). Changes in localized weather patterns associated with climate change may lead to more frequent and long-lasting droughts (Rind et al. 1990; Seager et al. 2007; and Rahel and Olden 2008). Climate warming may also increase the spread of non-native species (Rahel and Olden 2008). Changes in drought cycles and increases in air and soil temperatures could have effects on seed set, germination, and general fitness of Geocarpon (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 7

**Delisting Criteria:**
1. A total of 15 viable populations, representing the diversity of habitats and the geographic range of the species, are protected as necessary to ensure their continued existence (USFWS, 2009).

2. Populations include the wide spectrum of current genetic variation (USFWS, 2009).

3. Population viability is confirmed through periodic monitoring for at least a 15-year period (USFWS, 2009).

**Recovery Actions:**
- Protect viable populations across the species' geographic range (USFWS, 1993).
- Evaluate potential habitat and search for additional populations (USFWS, 1993).
- Continue to monitor known sites to determine population trends (USFWS, 1993).
- Support basic research investigating the chemical characterization of the plant's substrate and species biology, dispersal ecology, and population genetics (USFWS, 1993).
- Determine the effects of disturbance factors (natural and manmade) and incorporate findings into management prescriptions (USFWS, 1993).
- Preserve genetic stock (USFWS, 1993).
- Establish additional populations in the Arkansas Valley Natural Division, if deemed necessary (USFWS, 1993).
- Seek funding to complete an investigation into the genetic variability of Geocarpon throughout the range, including the newly discovered populations in Texas and Louisiana (USFWS, 2009).
- Continue to investigate the role of disturbance in the distribution and success of Geocarpon in sandstone glades and saline prairies (USFWS, 2009).
- Initiate studies to determine the mode of seed dispersal. Promising theories include movement by water, insects, and large mammals (USFWS, 2009).
- Continue to search for new populations in suitable sandstone glade habitats in Missouri and Arkansas and saline prairie habitats in the Arkansas River Valley of Arkansas and Oklahoma and other saline prairie sites in Arkansas, Louisiana, and Texas (USFWS, 2009).
- Continue to monitor known sites (USFWS, 2009).
- Work cooperatively with landowners to conserve privately owned sites through fee title or easement purchases or development of management agreements (USFWS, 2009).
- Complete the investigation into the genetic variability of Geocarpon throughout the plant's range (funded in 2015 with completion expected in 2017) to get a better understanding on possible completion of recovery criteria #2 (USFWS, 2016).
- Continue to investigate the role of disturbance in the distribution and success of Geocarpon in sandstone glades and saline prairies. The impacts of extreme disturbance due to feral hogs should be incorporated into these studies. As an understanding develops regarding the role of disturbance, a threats assessment should be conducted to determine which threats should be addressed first (USFWS, 2016).

- Develop standardized monitoring protocols and reach consensus among states regarding the delimitation of populations and sub-populations (USFWS, 2016).
- Continue to search for new populations in suitable sandstone glade habitats in Missouri and Arkansas and saline prairie habitats in the Arkansas River Valley of Arkansas and Oklahoma and other saline prairie sites in Arkansas, Louisiana, and Texas (USFWS, 2016).
- Select sites throughout the range to be demographically monitored. Where it is already occurring this should continue and it should be instituted at other representative sites throughout the range that are currently only monitored opportunistically for presence/absence or rough estimations of population (USFWS, 2016).
- Develop a long-term management plan based on the results of studies on genetics, the role of disturbance, and other life history studies. Specific recovery criteria that address the long-term protection and viability of Geocarpon should be developed as new information becomes available (USFWS, 2016).
- Work cooperatively with landowners to conserve privately owned sites through fee title or easement purchases or development of management agreements (USFWS, 2016).

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# SPECIES ACCOUNT: *Gilia tenuiflora ssp. arenaria* (Monterey gilia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An erect, densely pubescent herb with basal rosette leaves and funnel-shaped purple flowers (NatureServe, 2015).

**Taxonomy**

A member of the phlox family (Polemoniaceae). It has been observed that in the more inland areas of its distribution, Gilia tenuiflora ssp. arenaria has morphological characteristics that intergrade with G. t. ssp. tenuiflora (Dorrell-Canepa, 1994) (USFWS, 2008).

**Historical Range**

This subspecies is endemic to the Monterey Bay and Peninsula dune complexes (USFWS, 2008).

**Current Range**

Restricted to isolated sites within two coastal dune scrub communities along Monterey Bay and the Monterey Peninsula (NatureServe, 2015). Occurrences are distributed in discontinuous populations from Spanish Bay on the Monterey Peninsula north to Moss Landing in Monterey County, CA (USFWS 2008).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (NatureServe, 2015); self-pollination (USFWS, 1998)

**Lifespan**

Adult: 1 year (USFWS, 2008)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (NatureServe, 2015); soils seed bank, semi-open areas (USFWS, 2008)

**Reproduction Narrative**

Adult: Entirely animal pollinated; mixture of bees, butterflies, moths, long-tongued flies, hummingbirds (NatureServe, 2015). It is an annual plant. A recent study has shown that Gilia tenuiflora ssp. arenaria may have long-lived seeds which create a relatively persistent soil seed bank (Fox et al. 2005). Gilia t. ssp. arenaria requires semi-open areas of sandy soil to germinate and to thrive (L. Madison, pers. comm. 2006; B. Collins, pers. comm. 2006; B. Delgado, pers. comm. 2006) (USFWS, 2008). The species is thought to be primarily self-pollinating based on its stamens not protruding from the flower, no observations of pollinators, and very viable seed

(Dorrell-Canepa, in litt., 1995) (USFWS, 1998).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal strand (NatureServe, 2015); dune scrub, coastal sage scrub, maritime chaparral (USFWS, 2008)

**Geographic or Habitat Restraints or Barriers**

Adult: Dense vegetation (USFWS, 2008); occurs at or below 100 ft. elevation (USFWS, 1998)

**Environmental Specificity**

Adult: Narrow (USFWS, 2008)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 1998)

**Habitat Narrative**

Adult: Inhabits coastal strand (sandy beaches and dunes) (NatureServe, 2015). Gilia t. ssp. arenaria is typically associated with sandy soils of dune scrub, coastal sage scrub, and maritime chaparral vegetation types. The taxon is generally found in sparse scrub communities, and does not compete well in the denser vegetation structure often exhibited by many non-native species. (USFWS, 2008). The species occurs at elevations no higher than 30 meters (100 feet). The species is usually tolerant of small amounts of drifting sand, but tends to occur in stable sites with minimal sand accretion or deflation (USFWS, 1998).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dust-like seeds in many desert species, assumed to be wind dispersed (NatureServe, 2015).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

3 populations extirpated since listing (USFWS, 2008)

**Number of Populations:**

24 (USFWS, 2008)

**Population Size:**

Variable from year to year; 1,665 - 25,000 depending on location (USFWS, 2008)

**Population Narrative:**

There are likely 24 currently extant occurrences of Gilia tenuiflora ssp. arenaria. Three coastal populations have likely been extirpated since the time of listing. As an annual plant, Gilia tenuiflora ssp. arenaria can go through large changes in number of individuals from year to year, and late-season rainfall can markedly affect germination and growth (Dorrell-Canepa 1994; Fox et al. 2005). Population censuses that span at least 10 years have been conducted at only a few locations. The number of individuals at Marina State Beach has fluctuated from a low of 5,000 individuals in 1987 to a high of 25,000 individuals in 1993; the number of individuals at Salinas River State Beach has fluctuated from a low of 1,665 individuals in 1987 to a high of 13,500 individuals in 1993 (CNDDB 2006) (USFWS, 2008).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** One of the greatest current threats to this subspecies is continuing destruction of habitat due to development. While future development will be precluded at some sites by virtue of being transferred to entities that will manage for their conservation (e.g., Big Sur Land Trust, University of California, and BLM at former Fort Ord), other sites are slated for future development. The western areas of former Fort Ord that are to be developed are relatively small in acreage, but contain a high density of individuals. Six of 11 inland occurrences (55%) on public lands are under threat of at least partial development (USFWS, 2008).

**Stressor:** Herbivory (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory has been observed by individuals conducting surveys and research on this subspecies (L. Fox in litt. 2006; T. Hyland pers. com. 2006). This poses a potentially serious threat to this subspecies (Service 1998), but actual effects are currently unknown. Herbivory has been found to increase with an increase in cover for small herbivorous species such as rabbits (McGraw 2004) (USFWS, 2008).

**Stressor:** Nonnative plants (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** One of the main threats to this taxon is competition from invasive, non-native species (57 FR 27848). These species are typically able to colonize disturbed habitats and quickly reach high densities. In coastal areas, iceplant (Carpobrotus ssp.) and exotic annual grasses are the most problematic invasive species for Gilia tenuiflora ssp. arenaria. In inland areas, jubata grass (Cortaderia jubata), iceplant, and annual grasses (Festuca spp., Avena spp., and others) are the most problematic invasive species for G. t. ssp. arenaria (Mactec Engineering and Consulting Incorporated 2002, 2003, and 2004). Annual grasses are particularly difficult to remove once they have colonized an area. Non-native grasses decrease the suitability of habitat for G. t. ssp. arenaria due to excessive soil stabilization and litter accumulation (Pickart 1997, Russo et al. 1988) (USFWS, 2008).

**Stressor:** Inadequate vegetation management (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Other human-caused factors that could affect the inland occurrences at former Fort Ord, aside from those previously mentioned, are vegetation management activities that fail to create or maintain the open, sandy conditions necessary for continued survival and colonization by Gilia tenuiflora ssp. arenaria. These include the elimination of fire from chaparral communities, poorly timed (e.g., wet season) prescribed fires, the use of pre-fire treatments that result in increases in non-native species, and the use of mechanical vegetation clearing that leaves the chipped vegetation on the soil surface (Zander and Associates 2007) (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
1. Habitat occupied by the taxon that is needed to allow delisting has been secured with long-term commitments and, if possible, endowments to fund conservation of the native vegetation (USFWS, 2008).

2. Management measures are being implemented to address the threats of invasive species and other problems, including grazing, pedestrians, and off-road vehicles at some sites (USFWS, 2008).

3. Monitoring indicates that management actions are successful in reducing threats of invasive non-native species (USFWS, 2008).

4. Additional restored habitat has been secured, with evidence of either natural or artificial long-term establishment of additional populations, and long-term commitments (and endowments, where possible) to fund conservation of the native vegetation (USFWS, 2008).

**Delisting Criteria:**
1. Habitat throughout this taxon's range is protected from encroachment of non-native species, recreational activity (including off-road vehicles [ORVs] and horses), and development (USFWS, 2008).

2. Habitat throughout this taxon's range is restored to native vegetation at proper densities to allow natural colonization by this plant (USFWS, 2008).

3. Habitat throughout this taxon's range is monitored sufficiently to assure that local threats are spotted promptly (USFWS, 2008).

4. Enough plants are at enough locations throughout this taxon's range and within the protected vegetation to reasonably assure the viability of the taxon (USFWS, 2008).

5. (Re)introduced populations should be naturally reproducing in vegetation that also appears to be persisting without excessive maintenance or "gardening" (USFWS, 2008).

6. The determination that delisting is possible must be based on at least 15 years of monitoring for the endangered taxa, to include wet and drought years (USFWS, 2008).

**Recovery Actions:**

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plant (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).
- A reworking of the recovery criteria listed in the recovery plan should be undertaken. The specific population sizes recommended in delisting criteria #4 are difficult to correlate with the observed distribution of occurrences in the field. Using specific numbers for annual species with persistent seed banks, as previously discussed, is not necessarily valuable as an indicator of species status. A more useful indicator should be identified to indicate the quality and status of the habitat that is supporting the various populations (USFWS, 2008).
- Improved coordination between State and Federal agencies and local landowners would increase information sharing and maximize conservation and recovery efforts. Aside from the work being done for the re-use of former Fort Ord properties, very little communication is currently occurring between different parties involved with the management of this subspecies. Little or no information was available for many of the privately owned parcels of land believed to support occurrences of this subspecies. Attempts to establish conservation easements or acquire properties containing coastal dune habitat that supports this and other rare and endangered species should be made. Conducting surveys of these lands to determine whether or not extant populations still exist would be valuable. Directed oversight through coordination of information, overall strategies, and implementation of uniform methodologies would allow for implementation of much more powerful adaptive management techniques (USFWS, 2008).
- Long-term monitoring programs at more known occurrences of Gilia tenuiflora ssp. arenaria should be undertaken. Due to the strong influence of annual precipitation on observable population size, this monitoring should be habitat-based or in another way address the issue of dormant soil seed banks. This monitoring should include monitoring of pre-fire vegetation and herbivory rates on portions of former Fort Ord that will be burned under the prescribed burn plan in the Fort Ord draft HCP. Information regarding control of non-native plants, community structure, herbivory, and germination of G. t. ssp. arenaria from persisting seed banks or new colonization in cleared areas may provide invaluable information for future management efforts (USFWS, 2008).
- Initiate surveys to locate suitable habitat for out-planting sites in areas that are managed for conservation and that could support Gilia tenuiflora ssp. arenaria. For instance, outplantings to areas such as Salinas River National Wildlife Refuge could complement recovery efforts elsewhere. If populations were to become established in such areas, they could also function as seed bank sources or reserves for other populations that are at risk of extirpation (USFWS, 2008).
- Seed collection should be initiated where populations are at risk of extirpation, including at former Fort Ord. Seeds should be stored at appropriate facilities, such as the Rancho Santa

Ana Botanic Garden, for future greenhouse seed production, genetic analyses, or direct recovery plantings. In conjunction with this, genetic analyses should be initiated to determine the geographic boundaries of Gilia tenuiflora ssp. arenaria and G. t. ssp. tenuiflora and the level of interbreeding, if any, occurring in the wild populations. This should be done prior to out-plantings from questionable populations in order to maintain genetic distinctiveness and accurately assess habitat requirements for each taxon (USFWS, 2008).

- Initiate controlled burn studies on former Fort Ord to determine the recovery potential of inland populations lost to unnaturally dense shrub communities. This should be undertaken to determine the conservation value of potential reserve areas prior to the finalization of proposed HCPs (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-year review: 1. Use the recently completed range-wide surveys to establish and implement a series of monitoring areas to evaluate population trends throughout the range. 2. Convene a working group of land managers to discuss funding for invasive species control, monitoring, restoration, and best management practices for Monterey gilia. 3. Expand invasive species control programs throughout the coastal occurrences of Monterey gilia. 4. Establish ex situ seed banks for long term preservation of Monterey gilia. 5. Conduct genetic analyses and collect morphological data where overlap between closely related subspecies occur. (USFWS, 2020)

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# SPECIES ACCOUNT: *Gilia tenuiflora ssp. hoffmannii* (Hoffmann's slender-flowered gilia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/31/1997; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An annual herb, 6-12 cm tall. Flowers (April) are purplish and funnel-shaped, the top of the "funnel" widening to flat, pink lobes (NatureServe, 2015).

**Taxonomy**

A member of the phlox family (Polemoniaceae) (USFWS, 2009). In 1959, Munz included the varieties of tenuflora as subspecies, including ssp. hoffmannii, as per a 1956 treatment by the Grants (Munz and Keck 1973). This nomenclature was used in the latest treatment of the genus (Day 1993). Of the four subspecies of G. tenuiflora, the subspecies hoffmannii is the only one that occurs in southern California (USFWS, 2000).

**Historical Range**

Known from three locations on Santa Rosa Island of the northern Channel Islands. A collection was made by Reid Moran from the “arroyo between Ranch and Carrington Point” in 1941 (Rutherford and Thomas 1994). In 1994, Kathy Rindlaub located a population of 88 individuals covering 2 square meters (m) (21 square feet (ft.)) that reasonably corresponded to Moran’s site, and was grazed by cattle (Rindlaub 1994). The other historical location is at the type locality near East Point, where the species is still found today. It was not until 1994 surveys that Rindlaub discovered a third population that was 5 comprised of three colonies at Skunk Point on Santa Rosa Island. This population was comprised of approximately 3,000 to 3,500 individuals in 1994 and had been cropped by cattle (Rindlaub 1994) (USFWS, 2009).

**Current Range**

It is restricted to Santa Rosa Island off the coast of southern California. A third population was discovered in 1994 at Skunk Point (Rindlaub 1994) (USFWS, 2009).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2009)

**Lifespan**

Adult: 1 year (USFWS, 2009)

**Breeding Season**

Adult: April - May (USFWS, 2009)

**Key Resources Needed for Breeding**

Adult: Winter and spring rains (USFWS, 2009); insect pollinators (USFWS, 2000)

**Reproduction Narrative**

Adult: This is an annual plant. Plants germinate with winter or spring rains, primarily in January or February, and flowers and produces seed by late April or early May. An individual can produce from 200 to several hundred seeds (Faulkner and Chaney 2007) (USFWS, 2009). A small beefly (Otigodranes spp., Bombyliidae) was observed to be the most numerous and effective pollinator, and a soft-winged flower beetle (Melyridae) was observed as a casual visitor in a pollination study on south coast range Gilia tenuflora populations (Grant and Grant 1965). It is unknown if these species or their counterparts occur on Santa Rosa Island (USFWS, 2000).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Dune scrub (NatureServe, 2015); lupine scrub (USFWS, 2000)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2000)

**Habitat Narrative**

Adult: Inhabits sandy soils with dune scrub vegetation. (NatureServe, 2015). Gilia tenuiflora ssp. hoffmannii thrives in open patches of habitat where bare ground ranges from about 50 to 95 percent (Faulkner and Chaney 2007). Gilia tenuiflora ssp. hoffmannii can be found growing on ancient stabilized sand dunes on the northeastern side of Santa Rosa Island where soil textures are characterized by loamy sand. The species prefers open habitat among other low herbaceous vegetation where competition for resources is low (Faulkner and Chaney 2007) (USFWS, 2009). Hoffmann’s slender-flowered gilia is also a component of lupine scrub vegetation (USFWS, 2000).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Stable (USFWS, 2009)

**Number of Populations:**

3 (USFWS, 2022)

**Population Size:**

Variable depending on year; East Point: 20,000 - 256,000; Skunk Point: 3,000 - 3,500 (USFWS, 2009).

**Population Narrative:**

At the time of listing, three populations of Gilia tenuiflora ssp. hoffmannii were known on Santa Rosa Island; currently there are two known populations. Gilia tenuiflora ssp. hoffmannii populations exhibit large inter-annual fluctuations. The East Point and Skunk Point populations appear to be relatively stable since the time of listing (USFWS, 2009).

***Threats and Stressors***

**Stressor:** Grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In response to browsing, Gilia forms multiple side branches, and although a branched plant may produce a greater number of flowers, this does not necessarily increase the fecundity of the plant (Painter and Belsky 1993). Flowers produced later in the season out of synchrony with pollinator activity results in lower seed productivity (Painter in litt. 1997 as referenced in Service 1997). In the step-down narrative portion of the recovery plan, effective elimination of habitat damage from nonnative animals, particularly the deer and elk on Santa Rosa Island, was considered one of the most important management tasks needed for recovery of this species and other listed plant taxa (Service 2000). Some progress has been made toward eliminating nonnative animals from Santa Rosa Island since the time of listing. Although habitat conditions on Santa Rosa Island show the effects of long-term grazing, the USGS believes that at the landscape level, conditions are improving (McEachern in litt. 2007) (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Gilia tenuiflora ssp. hoffmannii is threatened by the risk of stochastic extinction due to small population size and limited distribution (Service 2000). In particular, the small size of each population makes it difficult for this species to persist while sustaining the impacts of soil damage and habitat alteration from nonnative species. The species remains vulnerable to extirpation due to its small population size, high inter-annual variability in plant numbers, and limited distribution (USFWS, 2009).

**Stressor:** Nonnative species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from nonnative grasses currently threatens the existence of Gilia tenuiflora ssp. hoffmannii and its habitat. An invasive annual grass, false brome (Brachypodium distachyon), was recently discovered within Gilia tenuiflora ssp. hoffmannii habitat on East Point on Santa Rosa Island. Both false brome and Gilia tenuiflora ssp. hoffmannii prefer open patches

of habitat. The invasive grass has the potential to displace Gilia as it fills in the open areas of habitat (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Gilia tenuiflora ssp. hoffmannii may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap regions that would be climatically favorable in the future (Levine et al. 2008). This potential threat is particularly acute for species on islands because they are unable to disperse to more favorable habitat as the environment changes. Sea level rise as a result of climate change has the potential to adversely affect Gilia tenuiflora ssp. hoffmannii and its habitat. In particular, ocean bluffs along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). In addition, Gilia tenuiflora ssp. hoffmannii may also be threatened by climate change because of its germination cues. According to the study conducted by Levine et al. (2008), Gilia tenuiflora ssp. hoffmannii exhibited the highest germination rates in the years of the coldest germination-inducing storms (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Establish 10 populations on Santa Rosa Island that are stable or increasing for a period of 15 years that includes the normal precipitation cycle. A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000) (USFWS, 2009).

Recovery Priority Number: 6

**Delisting Criteria:**
1. Discover or establish five additional populations (USFWS, 2009).

2. No decline after downlisting for 10 years (USFWS, 2009).

**Recovery Actions:**
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the species and its habitats (USFWS, 2000).
- Conduct thorough surveys for the species (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species (USFWS, 2000).

- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).
- The USGS and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine the generalized downlisting criteria to take into consideration new information. Attaining the recovery criteria outlined in the recovery plan is unrealistic for this species (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines in the species (USFWS, 2009).
- The USGS and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends of the species (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue monitoring the East Point population of Gilia tenuiflora ssp. hoffmannii. 2. Better define suitable germination and growth microhabitat for Gilia tenuiflora ssp. hoffmannii, especially in relationship to non-native grass Brachpodium distachyon competition. 3. Control and strive for eradication of Brachypodium distachyon at the East Point occurrence. 4. Establish a regular survey monitoring schedule for Gilia tenuiflora ssp. hoffmannii at the Skunk Point and Carrington Point populations. 5. Collect seed, especially from the Skunk Point and Carrington Point populations, for restoration seed bulking, and augment these populations with population-specific seed to boost population sizes. 6. Improve the completeness of coverage of Gilia tenuiflora ssp. hoffmannii in conservation seed banks, with all populations over a wider range of years (USFWS, 2022).

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# SPECIES ACCOUNT: *Grindelia fraxinipratensis* (Ash Meadows gumplant)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 05/20/1985; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

It is an erect biennial or more commonly a perennial herb, reaching 25 to 40 inches in height and has yellow flowers with heads measuring 0.3 to 0.4 inches in diameter (Mozingo and Williams 1980). The gumplant genus is so named because of their very sticky (gummy) flower heads (USFWS, 2007).

**Taxonomy**

Kartesz (1999) used the spelling 'fraxinopratensis'. According to comments in the Index to California Plant Names (part of the Jepson Interchange for California Floristics, April 2012) "fraxinipratensis" is the correct spelling. It is a member of the Asteraceae (sunflower family) (NatureServe, 2015).

**Historical Range**

It is endemic to the greater Ash Meadows region in Nye Co., Nevada and Inyo Co., California. (NatureServe, 2015). Cochrane (1981) believes that its distribution was continuous prior to perturbation for agriculture (USFWS, 1990).

**Current Range**

Most of its distribution is within the Ash Meadows National Wildlife Refuge (Refuge). One population occurs outside the Refuge boundary in the Carson Slough, primarily within the Ash Meadows Area of Critical Environmental Concern (ACEC) managed by Bureau of Land Management (BLM) in Nevada. Based on anecdotal observations and assessments of biologists, it appears Ash Meadows gumplant distribution has likely increased since the species was listed (Service 2001) (USFWS, 2008).

**Critical Habitat Designated**

Yes; 5/20/1985.

**Legal Description**

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Grindelia fraxinipratensis (Ash Meadows gumplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California and Nevada (50 FR 20777-20794).

**Critical Habitat Designation**

The critical habitat designation for Grindelia fraxinipratensis includes two CHUs in Inyo County, California and Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

California, Inyo County, Ash Meadows.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Grindelia fraxinipratensis critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include saltgrass meadows along streams and pools or drier areas with alkali clay soils.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2008)

**Lifespan**

Adult: 2+ years (NatureServe, 2015)

**Breeding Season**

Adult: Summer - fall (USFWS, 1990)

**Reproduction Narrative**

Adult: It is a biennial or more commonly a perennial plant (NatureServe, 2015). In a good year, each plant may produce several hundred seeds (Lane 1993) (USFWS, 2008). It flowers during the summer and autumn (USFWS, 1990).

**Habitat Type**

Adult: Terrestrial, riparian, wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Saltgrass meadows (NatureServe, 2015); ash-screwbean mesquite woodlands, desert shadscale scrub, clay barrens (USFWS, 2008)

**Environmental Specificity**

Adult: Very narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits saltgrass meadows along streams and pools; occasionally occurs in alkali clay soils in drier areas. Dependent on moisture available from streams (NatureServe, 2015). Ash Meadows gumplant is found primarily in the vicinity of ash-screwbean mesquite woodlands and desert shadscale scrub vegetation. It occasionally occurs sparsely in drier shadscale habitats or in the unique clay barrens. Over 30 percent of the Refuge has been mapped as wet meadow and is dependent on flows from several dozen springs and seeps (Otis Bay 2006). These springs and seeps are fed by an extensive groundwater system (USFWS, 2008). Extant populations are scattered throughout the area at sites that have not been disturbed or have been allowed to restabilized from disturbance for extended periods (USFWS, 1990).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal of the small seed is most likely accomplished by strong winds because they could be blown for some distance. Those seeds which fall within close proximity of the parent plant could be further transported by water during the winter rainy season or during summer flash floods. Mammals and birds may also be responsible for dispersal of seeds (Cochrane 1981) (USFWS, 2008).

***Population Information and Trends***

**Number of Populations:**

2 Population Services (USFWS, 2020)

**Population Size:**

~ 898,404 (USFWS, 2020)

**Population Narrative:**

The Ash Meadows gumplant is concentrated in three main populations and several smaller ones over an area of approximately 2,260 acres (BLM and Service 2000). There is little quantitative population or demographic data to describe trends for the Ash Meadows gumplant. The 2000 Environmental Assessment to withdraw lands from mineral entry estimated the entire Ash Meadows gumplant population to contain 81,000 plants within 2,260 acres (BLM and Service 2000). This number, based on visual estimates, is a serious underestimate of the total number of plants because a 2002 survey of the California population, which used transects to develop a population estimate, estimated 241,514 ± 69,660 plants within 88 acres (Soil Ecology and Restoration Group 2004) (USFWS, 2008).

***Threats and Stressors***

**Stressor:** Groundwater pumping (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Groundwater availability is a regional phenomenon; thus groundwater pumping in the vicinity would impact the entire Ash Meadows ecosystem, including habitat that supports the Ash Meadows gumplant. Groundwater rights in Nevada are regulated by the State Engineer. In theory, the water rights owned by the Refuge are protected. However, in recent hearings, the National Park Service testified the number of water rights issued by the State of Nevada for the Amargosa Valley has grossly exceeded sustainable withdrawal levels and the resource is over-allocated (Baldino 2006a). It is important that current groundwater monitoring continues to ensure regional extractions do not affect the species (USFWS, 2008).

**Stressor:** Nonnative species (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** As in the case of noxious agricultural weeds present on the Refuge, many invasive species have adaptations that allow them to outcompete native vegetation and colonize previously undisturbed habitat. The wet meadows that support Ash Meadows gumplant provide an especially favorable environment for invasive species that would not otherwise be able to survive in the desert. On the Refuge, there are an estimated 4,460 acres of former agricultural fields previously used for crop production and livestock grazing (Service, 2006). These fields, situated adjacent to two of the largest Ash Meadows gumplant populations, are now largely monocultures of Russian knapweed, bassia and Malta star thistle. In many parts of the Refuge, these non-native species are expanding beyond the fields into surrounding Ash Meadows gumplant habitat (Service 2006). Fire facilitated by non-native species is a new threat to Ash Meadows gumplant not identified in the original listing. Non-native species are known to alter fire regimes and are a threat to biodiversity (Brooks et al. 2004). In some areas of the Refuge, non-native salt cedar trees (Tamarix sp.) and red brome grass (Bromus madritensis) increase the ease with which fire spreads through riparian corridors and along the spring channels that comprise Ash Meadows gumplant habitat. In the past two years, three major fires (the Meadows Fire, Longstreet Fire, and Ash Fire) have burned 144 acres (roughly 6%) of Ash Meadows gumplant habitat. Following the Meadows Fire, Russian knapweed populations exploded to create monocultures that now likely prevent regrowth and colonization of native vegetation, including the Ash Meadows gumplant (Baldino 2006a). Ash Meadows gumplant habitat is extremely vulnerable to being altered by non-native species. If left untreated the consequences would likely be decreases in the population of Ash Meadows gumplant, both due to competitive exclusion, and additional population reductions resulting from increased fire frequencies (USFWS, 2008).

**Stressor:** Surface mining (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Active mineral claims within Ash Meadows could cause direct loss of habitat, as well as indirect impacts to the species by diverting or draining water away from habitat during mining activities. There are 29 active mining claims on BLM lands in and near the Refuge and critical habitat for the species (BLM 2007). Approximately 45 percent of the occupied Ash Meadows gumplant habitat within the Refuge boundary is on BLM and Service lands with a high mineral potential and are open to public minerals (BLM and Service 2000) (USFWS, 2008).

**Stressor:** Off-highway vehicles (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Illegal OHV activity has recently become a problem again on the Refuge, possibly due to a fence in need of repair (Baldino 2006b). Repairs to the fence and monitoring of OHV activity will be an ongoing necessity at the Refuge (USFWS, 2008).

**Stressor:** Stochastic events (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Small populations have an inherent risk of extinction due to stochastic and natural catastrophic events. Fire and flooding are natural catastrophic events that occur within Ash Meadows gumplant range. Given the species' distribution on the Refuge, fire is the catastrophic event most likely to affect the Ash Meadows gumplant. Although possible, it is unlikely that any one fire could affect a major portion of the Ash Meadow gumplant distribution throughout its entire range. However, increased fuel loads from non-native species can lead to more frequent fires in the Mojave Desert (Brooks and Pyke 2001) (USFWS, 2008).

**Stressor:** Feral Horses (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** We received a correspondence from Rancho Santa Ana Botanic Garden (2019). They state results are preliminary and not yet available for surveys of the Ash Meadows gumplant in California. They also reported that feral horses have been documented in occupied Ash Meadows gumplant habitat in lower Carson Slough in 2018 and 2019, and thus remain a threat. We received a recent monitoring report from Ash Meadows NWR (Pyramid Botanical Consultants, 2019). The results indicate the species is still present at all previously known populations within the refuge, and species distribution remains the same as described in our most recent 5-year review (Service, 2008). (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 14

**Delisting Criteria:**
1. Secure, protect, and maintain the species in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of the species within essential habitat (USFWS, 2008).

2. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 2008).

3. The species is present in all the sites that it has historically occupied (USFWS, 2008).

4. The listed plant has a frequency value equal to or greater than the frequency value determined by comparison with unaltered reference sites as an indicator of a self-sustaining plant populations (USFWS, 2008).

**Recovery Actions:**
- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new & existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).

- The population monitoring described in the Recovery Plan should be carried out (USFWS, 2008).
- The Refuge is implementing many restoration projects that could benefit the Ash Meadows gumplant. To document recovery of the Ash Meadows gumplant, these projects should include pre- and post-site sampling to verify and quantify that restoration actions are benefiting the species (USFWS, 2008).
- Non-native weeds are a major threat to the Ash Meadows gumplant, and the IPM Plan is an important step towards addressing this problem. Long-term funding should be secured for non-native species control on the Refuge (USFWS, 2008).
- Interactions between fire and non-native weeds within Ash Meadows gumplant habitat and effects on the Ash Meadows gumplant need to be studied (USFWS, 2008).
- Surface mining remains a threat to the Ash Meadows gumplant. Service and BLM lands with a high mineral potential must be withdrawn from future mineral entry. In addition, existing mining claims should be acquired when possible. Unless these mineral rights are purchased or transferred to the Service, a program needs to be put in place to renew existing mineral withdrawals every 20 years (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); and III. Support Ash Meadows gumplant research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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# SPECIES ACCOUNT: *Hackelia venusta* (Showy stickseed)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/08/2002; Pacific Region (Region 1)

**Physical Description**

Hackelia venusta is a moderately stout perennial plant, 20-40 cm (8-16 inches) tall, with numerous flowering stems arising from a slender taproot. Large showy flowers are white or white washed with blue, with five lobes topping the end of a short corolla tube. Flowering occurs in April or May. Leaves are basal and numerous on the flowering stem. The fruit consists of four prickly nutlets which drop near the plant but the spurred fruit can be dispersed by clinging to the hair of passing animals (USFWS 2007). (NatureServe, 2015)

**Taxonomy**

This species was first described within the genus Lappula (annual plants) but later transferred to the genus Hackelia (perennial plants). Carr (1974) undertook a taxonomic study of the genus in western North America and recognized Hackelia venusta as a morphologically uniform, distinct species that exhibited little variability. A further taxonomic review (Harrod et al 1999) indicated that certain high elevation populations previously assigned to H. venusta were a distinct undescribed species, Hackelia taylori (Harrod et al. in review). Harrod and his colleagues (1999) further outline that no affinities exist between the low and high elevation taxon, nor with nearby populations of H. diffusa var. arida. (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

This species is known from one location only in Chelan County, Washington. (USFWS, 2011)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (outcrossing) (USFWS, 2007)

**Lifespan**

Adult: >10 years (USFWS, 2007)

**Dependency on Other Individuals or Species**

Adult: Insect pollinators (USFWS, 2007)

**Breeding Season**

Adult: April to June (USFWS, 2007)

**Reproduction Narrative**

Adult: Hackelia venusta is perennial, and individual plants can live for at least 10 years. Flowers begin to open in late April, and new flowers are continuously added to each inflorescence until late June. By mid-June, the lowest flowers have nearly mature fruits. Dispersal begins with the lowest flowers and continues for several weeks into early July (Gamon 1997). It is possible that H. venusta could be pollinated by moths; however, this is unlikely because the relatively long tongues of moths are an apparent mismatch with the short corolla tube length of H. venusta. If the species is insect pollinated, bee and fly species appear to be the most likely candidates, as they have shorter tongues that better match the corolla tube length of H. venusta. In the past, H. venusta has been assumed to be an obligate outcrosser (Harrod 1999). Three pollinators were verified on the H. venusta plants: two bees, Andrena nigrocaerulea and Protosmia rubifloris, and one fly, Eulonchus sp. This work has indicated H. venusta is primarily outcrossing, with the possibility of geitonogamous selfing (pollination by other flowers on the same plant); autogamous selfing (pollination within a single flower) is possible since the stigma and anthers do appear to be in close proximity with one another at anthesis, but is unlikely to be a major contributor because most of a flower's pollen is produced before its stigma is receptive (J. Taylor, pers. comm. 2005, 2007). (USFWS, 2007)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Bare rock/talus/scree, cliff, forest- conifer, forest/woodland (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations between 472 meters (1,550 feet) to 823 meters (2,700 feet); prefers open, sparsely vegetated areas (shade intolerant) (USFWS, 2007)

**Spatial Arrangements of the Population**

Adult: Scattered (USFWS, 2007)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Hackelia venusta is shade-intolerant (R. Carr, pers. comm. 1998) and grows in openings within Pinus ponderosa (ponderosa pine) and Pseudotsuga menziesii (Douglas-fir) forest types. This vegetation type is described as the Douglas-fir zone by Franklin and Dyrness (1973). Common associates include Penstemon subserratus (finetooth beardtongue), Phacelia hastata (silverleaf phacelia), Lomatium triternatum (nineleaf biscuitroot), Lupinus wyethii (Wyeth's lupine), Eriogonum compositum (arrowleaf buckwheat), Eriogonum umbellatum var. hypoleium (sulphur-flower buckwheat), Hieracium cynoglossoides (houndstongue hawkweed), and Pseudoroegneria spicata (bluebunch wheatgrass). Hackelia venusta is found on open, steep slopes (minimum 80 percent inclination) of loose, well-drained, granitic weathered and broken rock fragmented soils, and on ledges and cracks on granitic cliff faces, at elevations between 472 meters (1,550 feet) to 823 meters (2,700 feet). Aspect ranges from 192 degrees (south-southwest [SSW]) to 310 degrees (west-northwest [WNW]), with most plants at an aspect of 265 degrees (west [W]). Plants are found on concave, convex, or flat slopes. The primary subpopulation is on an area of slope between drainages, but a number of the smaller subpopulations occur along the steep south-facing sides of dry drainages or on vertical cliff faces. Hackelia venusta appears to be somewhat adapted to natural and possibly human-caused substrate disturbance (R. Carr, pers. comm. 1998), and occurs within the right of way along both sides of Highway 2. Although potential habitat for this species exists elsewhere in Tumwater Canyon, and occasionally single plants are seen elsewhere along Highway 2, no other populations have yet been found. Wildfires play a role in maintaining open, sparsely vegetated sites as suitable habitat for Hackelia venusta, a requirement of this shade-intolerant plant (R. Carr, pers. comm. 1998, in litt. 2000). The range of Hackelia venusta has been reduced to a small single population occurring in a scattered distribution across roughly 16 hectares (40 acres) in Tumwater Canyon. (USFWS, 2007)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Most nutlets seem to fall directly to the ground around the parent plant, but the topography is so steep and unstable that many nutlets are carried downslope. Small concave areas near parent plants often have seedlings (L. Malmquist, pers. comm. 2003). The prickly nutlets are also well adapted for dispersal by adhesion to the coats of passing animals (Gamon 1997). (USFWS, 2007)

***Population Information and Trends***

**Number of Populations:**

1 core pop, 5 outplanted with limited success (USFWS, 2020)

**Population Size:**

~477 at core pop and an unknown number of reintroduced (USFWS, 2011)

**Population Narrative:**

The core population was last surveyed in 2012 when 477 plants were documented (Fertig 2019, p. 36-37). Since 2012 only outplanting plots have been surveyed. The core population has not been surveyed since 2012 due to concerns about the potential for on foot surveys to damage seedlings and decrease the stability of the granitic sandy soils where the plants occur in unstable, steep slopes. Visual surveys indicate the species is still present at the core population without noticeable change, but no quantitative assessment of the core population has occurred since 2012. Implementation of recovery actions since 2011 include seed collection, growing plants from seed at the UW Rare Care Program and conducting outplantings in Tumwater Canyon and Icicle Creek Canyon in 2015 and 2019. A total of 228 individuals were planted at four sites in Tumwater Canyon adjacent to the core population in 2015 and another 39 were reintroduced to a former outplanting site near Icicle Creek (Arnett and Goldner 2017). According to the most recent surveys in May of 2020 by the UW Rare Plant Care Program the overall survival rate of the 2015 outplantings is 22 percent (with only three plants remaining at the Icicle Creek site) (Gibble 2020). In 2019 seedlings were observed at the outplanting sites and in 2020 two, second year plants were observed in the Tumwater Canyon outplanting site. In October of 2019, approximately 200 plants were planted at three plots adjacent to the core population and between the 2015 outplanting plots in Tumwater Canyon. The first year survival rate of these outplantings was 61 percent, which was much lower than the first year survival rate of the 2015 outplantings (80 percent survival rate). Evidence indicated 85 percent of the plants survived the winter, and most of the loss occurred in April, which was much drier than normal. Highest mortality occurred at the sites with the most sun exposure and least shade. (Gibble 2020). One new outplanted population was also planted in October of 2019 approximately 1.5 miles north from the core population in Tumwater Canyon on an area of Forest Service land with similar soils and aspect to the core population. The new outplanted population consisted of approximately 100 individuals. When surveyed in May of 2020, the plants at the new population north of the core population had an overall survival rate of 37 percent, with approximately half of the mortality occurring over the winter and half in the spring. (Gibble 2020). (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Plant succession (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary loss of habitat for Hackelia venusta has resulted from changes in habitat due to plant succession in the absence of fire. Fire suppression has been a factor in reducing the extent of the Tumwater Canyon population (Gamon 1988a, b; D. Werntz, in litt. 2000), and most likely the few hundred acres of occupied habitat recorded in 1968 (Gentry and Carr 1976) represented a population that had already been reduced in both numbers and range due to fire suppression activities that had been ongoing for many years. Historically, fuels in the forest type where H. venusta is found were rarely at high levels because of the frequent fires that consumed forest floor fuels and pruned residual trees (Agee 1993). In the past, fires suppressed the encroachment of woody vegetation and maintained open areas presumably more conducive to H. venusta reproduction and growth. As described above, wildfires play a role in maintaining open, sparsely vegetated sites as suitable habitat for this shade-intolerant species (R. Carr, pers. comm. 1998; D. Werntz, in litt. 2000). (USFWS, 2007)

**Stressor:** Non-native plants (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Two nonnative, Washington State-listed noxious weeds (Washington Administrative Code Chapter 16-750 and Revised Code of Washington Chapter 17-10) occur within the habitat of Hackelia venusta in Tumwater Canyon. Linaria dalmatica (dalmatian toadflax) and Centaurea diffusa (diffuse knapweed) are present along the roadside, and the former also occurs above the main portion of the population (F. Caplow, pers. obs. 2004). During visits to the H. venusta population in 1995 through 1998, U.S. Fish and Wildlife Service staff noted that the cover and distribution of the noxious weeds had increased over this time period (T. Thomas, pers. obs. 1998). Both of these noxious weeds outcompete many native plant species through uptake of water and nutrients, interference with photosynthesis and respiration of associated species, and production of compounds that may directly affect seed germination and seedling growth and development. Without intervention, these species have the ability to outcompete H. venusta and replace native vegetation, and eventually dominate the site (J. Wentworth, King County Noxious Weed Control Board, in litt. 2001). (USFWS, 2007)

**Stressor:** Highway maintenance (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Highway maintenance activities are an ongoing threat to the population of Hackelia venusta. The highway is sanded during winter months, and de-icers are also occasionally applied, affecting the immediate roadside habitat where H. venusta is found. Since 1998, the Washington Department of Transportation has been using de-icers on the roadway during winter months. The de-icer used by the Department is called CalBan, a formulation of calcium chloride, which is a salt. Solutions of the salts accumulate in the soil and are retained on soil particles. The decline of H. venusta along the roadcut and right of way corresponds to an increase in noxious weeds and the Washington Department of Transportation's use of de-icers starting in 1998. De-icers may be associated with the decline of individual plants in the right-of-way and it is now considered a threat to the species. A study of the effect of de-icers used by the Washington Department of Transportation on surrogate species found deleterious effects on survival and biomass at concentrations above 1:100 (Chalker-Scott and Brickey 2004), although the authors do not believe concentrations this high occur at the H. venusta site. The Washington Department of Transportation is aware of the potential threat to H. venusta, and has been actively cooperating with the U.S. Fish and Wildlife Service, U.S. Forest Service, and the Washington Department of Natural Resources to plan and manage their maintenance activities so as to minimize impacts on the rare plant species of Tumwater Canyon (Washington Department of Transportation [WDOT] 2000; see Section G, Conservation Measures, for further details). (USFWS, 2007)

**Stressor:** Herbicides (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although the roadsides have not been sprayed with herbicides in recent years by the Washington Department of Transportation, spraying did occur for a considerable period of time prior to 1980. The residual effect of herbicide spraying on Hackelia venusta is unknown. Some herbicides are known to reside in the soil for long periods of time, affecting the plants that persist there. In 1999 and 2000, the application of herbicides by U.S. Forest Service personnel was used as a method for reducing the amount and distribution of nonnative, noxious weeds (L. Malmquist, pers. comm. 2003). Although they were used with great caution by U.S. Forest Service staff with knowledge of H. venusta's presence, the threat from herbicide drift and residue remains. (USFWS, 2007)

**Stressor:** Erosion and landslides (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small surface erosion events and large landslides on the unstable slope where the Hackelia venusta population is located are a continuing threat to the species. The steepness of the slope exceeds 100 percent (45 degree) inclination in many places, and the slope's instability constitutes a significant threat as a major landslide could bury most of the population (Gamon 1997). The last time a large landslide occurred, in 1992, the road was closed for emergency

repairs by the Washington Department of Transportation. The repairs undercut the slope and at least 50 H. venusta plants were destroyed (R. Harrod, pers. comm. 2001). The population census numbers continued to decrease for several years after the landslide. (USFWS, 2007)

**Stressor:** Burying, trampling, or dislodging of plants by soil releases (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threat of soil being dislodged and the burying, trampling, or dislodging of plants below these soil releases has been witnessed as more people visit the habitat to photograph or collect Hackelia venusta (S. Ballinger, Biologist in litt. 2000; P. Camp, Bureau of Land Management, in litt. 2000; F. Caplow, in litt. 2000; J. Frazee, U.S. Forest Service, in litt. 2000; K. Robson, Cowlitz and Wahkiakum Conservation Districts, in litt. 2001). The potential for slumping (deep-seated mass movement) at the site has increased since 1994, when wildfires burned through the forest in Tumwater Canyon where the species is located. The increased potential for landslides occurs when water uptake by trees and other vegetation that were killed by the 1994 fire is reduced, along with transpiration, so there is more soil water, which increases instability. This is a case where the response to fire may have negative consequences. Another contributing factor is that when tree roots decompose, their ability to bind soil particles and water is decreased. When this happens, the potential for landslides increases. A large landslide in the location of the Tumwater Canyon population of H. venusta would severely degrade the habitat and reduce the plant population. (USFWS, 2007)

**Stressor:** Automobile emissions (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although there are no data regarding the effects of automobile emissions on Hackelia venusta specifically, such emissions should be considered a potential threat, given the proximity of the road to the population. The highway is heavily used, with between 3,900 to 5,200 automobiles traveling daily through Tumwater Canyon, which is very narrow (WDOT 1996). Automobile emissions are likely to increase along this heavily traveled corridor. These emissions, containing ozone and sulphur and nitrate oxides, are known to negatively affect photosynthesis of coniferous and herbaceous plants (Bega 1979), and may increase nitrogen in the soil, thereby increasing the cover and vigor of competing vegetation. (USFWS, 2007)

**Stressor:** Collection pressure
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There is a long history of collection pressure on Hackelia venusta. (R. Carr, in litt. 2000; L. Malmquist, in litt. 2000; J. Brickey, University of Washington, in litt. 2001; R. Crawford, Washington Department of Natural Resources, in litt. 2001; E. Guerrant, in litt. 2001; K. Robson, in litt. 2001). H. venusta is very showy and has been collected by scientists, amateur wildflower enthusiasts, and other visitors to the population for more than 30 years. The availability of highway turnouts, and a general increase in knowledge and interest in the species are likely to have increased collecting pressure. Collecting activities may have reduced the number of plants in the population and have also degraded the habitat (Gamon 1997; R. Carr, in litt. 2000; R.

Crawford, in litt. 2000, 2001; R. Harrod, in litt. 2000; G. Hoffman, U.S. Forest Service, in litt. 2000; F. Caplow, in litt. 2001). (USFWS, 2007)

**Stressor:** Human activities (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An associated and serious threat is physical disturbance to the habitat and the individual plants from people trampling the slope to collect or see plants, photograph the plants, and monitor the population. Physical disturbance to the substrate increases instability, may damage the root systems of adult plants, and may also cause higher mortality of germinants (F. Caplow, pers. obs. 2003). (USFWS, 2007)

**Stressor:** Biocontrol agent (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** However, there is a potential threat from a new biocontrol agent. Mogulones cruciger is a weevil that attacks the nonnative hound's-tongue, Cynoglossum officinale (gypsyflower), which is also in the borage family. Cynoglossum officinale is known from Chelan County. The biocontrol agent has not been formally released in the United States, but has been released in Canada. (USFWS, 2007)

**Stressor:** Predation by weevils (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A laboratory-based study, using tissue-culture clones of H. venusta, found that M. cruciger was able to develop and feed to a limited extent on H. venusta. However, in both laboratory and field experiments M. cruciger demonstrated a strong preference for Cynoglossum (J. Andreas, University of Idaho, in litt. 2004). The investigator concluded that M. cruciger could pose some risks to native species of Boraginaceae and recommended that the weevil not be released in the United States. However, the weevil may spread from Canada and has been identified in the Okanagan Region of British Columbia (S. Reichard, pers. comm. 2003). (USFWS, 2007)

**Stressor:** Low seed production (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Low seed production is a factor in the decline of Hackelia venusta. At the Tumwater Canyon site, an estimated high proportion (60 to 70 percent) of H. venusta seeds did not develop in 1984 (Barrett et al. 1985). Fruit development was poor on many plants; only a few individuals exhibited mature fruit development. Low fruit production has been observed in other years as well (L. Malmquist, pers. comm. 2002). This low or variable reproductive potential may be a major factor in the small number of plants at the type locality. The age structure of the extant population at Tumwater Canyon, poor seed production and germination of new seedlings, and historical estimates of population size indicate that the population has been in decline (Barrett et

al. 1985; Gamon 1997), although recent monitoring of the population shows that the population has increased during the period from 1995 to 2004. The increase in population size can likely be attributed to the improved habitat conditions brought on by restoration activities and the effects of a wildfire that burned through Tumwater Canyon in 1994. (USFWS, 2007)

**Stressor:** Small population size (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The small size of the only known population of Hackelia venusta is a major problem for recovery. Seedling establishment is most critical, and trampling may significantly affect the germination of seedlings (R. Carr, pers. comm. 1998, in litt. 2000; K. Robson, in litt. 2001). The small number of individuals (roughly 600 plants) remaining in the sole population located in Tumwater Canyon makes H. venusta vulnerable to extinction due to random events such as slope failure (mass wasting or surface erosion) or drought. A single random environmental event could extirpate a substantial portion or all of the remaining individuals of this species, leading to extinction. Also, changes in gene frequencies within small, isolated populations can lead to a loss of genetic variability and a reduced likelihood of long-term viability (Franklin 1980; Soulé 1980; Lande and Barrowclough 1987; R. Carr, in litt. 2000). (USFWS, 2007)

***Recovery***

**Reclassification Criteria:**
Hackelia venusta may be considered for downlisting to threatened status when all of the following conditions have been met to address the threats to the species: (USFWS, 2019)

1. Listing/Recovery Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range. In order to ensure the long-term recovery needs of Hackelia venusta, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred: (a) Tree and shrub cover in all populations is maintained at a level equal to or more open than that present in 2007 in the original population, through manual removal or controlled burns. (b) Noxious weed populations are not present within any populations or close enough to them to pose a significant threat of invasion, or are annually removed. (c) Herbicide and de-icer use continues to be minimized within all populations or close enough to them that individuals may be affected. (d) All population sites have been evaluated for mass wasting potential and plans have been developed and implemented to minimize the effects of landslides on H. venusta. (USFWS, 2019)

2. Listing/Recovery Factor B: Overutilization for commercial, scientific, or educational purposes. Hackelia venusta is vulnerable to overcollecting of seeds or plants, and to habitat damage through substrate disturbance. In order to ensure the long-term recovery of H. venusta, threats to the species through collecting and visitation must be reduced or removed. This will have been accomplished if the following have occurred: (a) Seed collection guidelines are established. (b) A guideline of not sharing specific site information with the public or the press has been accepted by the U.S. Forest Service. * The quantitative measure of tree and shrub cover must be determined (Recovery Action 1.7.1). (c) The pullout across the highway from the population has been modified or removed to discourage the public from stopping their vehicles and crossing the highway. (d) The U.S. Forest Service has an entry log in place and all permitted entries into

the population are logged. (e) All research within the population is approved by the U.S. Fish and Wildlife Service and the U.S. Forest Service after review by the recovery team. (USFWS, 2019)

3. Listing/Recovery Factor C: Disease or predation. The viability of Hackelia venusta could be compromised by the presence of the borage-specific biocontrol weevil, Mogulones cruciger. In order to ensure the long-term recovery needs of H. venusta, threats to the species through predation by the biocontrol agent must be reduced or removed. This will have been accomplished if the following have occurred: (a) A monitoring program is in place to inspect H. venusta and identified populations of Cynoglossum officinale (gypsyflower) in Chelan County on an annual basis for the presence of the biocontrol weevil, Mogulones cruciger. (b) A written plan is in place for actions to undertake if the weevil is found and determined to have negative effects on H. venusta. (USFWS, 2019)

4. Listing/Recovery Factor D: Inadequacy of existing regulatory mechanisms. In order to ensure the long-term recovery needs of Hackelia venusta, regulatory mechanisms need to be strengthened. This will have been accomplished if the following have occurred: (a) Habitat management plans have been developed and implemented by the U.S. Forest Service. Management plans will include provisions, as appropriate, for habitat maintenance and restoration, noxious weed control, fire management, recreational activities, monitoring, and research. (b) A revised management plan has been developed and implemented by the Washington Department of Transportation. The management plan will include provisions, as appropriate, for habitat maintenance and restoration, noxious weed control, and highway maintenance activities. (c) All H. venusta populations on public lands are within management areas where maintenance of the species is a primary management goal. (USFWS, 2019)

5. Listing/Recovery Factor E: Other natural or manmade factors affecting its continued existence. The long-term recovery needs of Hackelia venusta require more populations that are stable and self-sustaining. The genetic resources of the species must also be adequately protected through seed storage, in case of catastrophic events in Tumwater Canyon. This will have been accomplished if the following have occurred: (a). At least three stable, self-sustaining populations are present within Tumwater Canyon on protected sites (owned or managed by a government agency or private conservation organization that identifies maintenance of H. venusta as the primary management objective for the site), separated by at least 2 kilometers (1.2 miles) or by the Wenatchee River. These populations could be the result of identification through further inventory, or through reintroduction or augmentation. If a new population is discovered outside of Tumwater Canyon, it may contribute to meeting this criterion. To be deemed stable and self-sustaining, a population must maintain a 5-year average of at least 1,000 adult plants, must show evidence of positive or neutral population growth over the same 5-year period, and must show evidence of natural reproduction and establishment. b. Genetic material, in the form of seeds adequately representing the geographic distribution and genetic diversity within the species, is stored in at least one facility approved by the Center for Plant Conservation. (USFWS, 2019)

6. Monitoring. In order to ensure the efficacy of recovery actions and allow for adaptive management, as necessary, population and habitat monitoring will have been established for all populations of the taxon at appropriate intervals. Habitat monitoring should include census, monitoring of Hackelia venusta, and of shrub and tree cover and nonnative species. Monitoring

must be planned and conducted to minimize the potential negative impacts on the species and its habitat. Written agreements to continue monitoring after downlisting must be in place. (USFWS, 2019)

Recovery Priority Number: 5

**Delisting Criteria:**
Delisting of Hackelia venusta may be considered when all of the following conditions, in addition to the downlisting criteria set in the Recovery Plan (USFWS 2007), have been met to address threats to the species: (USFWS, 2019)

Criterion A/1: The primary threats are removed or adequately managed in all five populations counted toward recovery in delisting criteria (see also Criterion E/1). (USFWS, 2019)

Criterion B/1: Threats to the species through visitation should be removed. (USFWS, 2019)

Criterion E/1: There are at least five stable, self-sustaining populations typically separated by 1.5 miles or by a geographical barrier such as the Wenatchee River on protected sites where protection of the species is a priority.  (USFWS, 2019)

Criterion E/2: To be deemed stable and self-sustaining, a population should maintain a 20- year running average of at least 2,000 adult plants, show evidence of positive or neutral population growth over the same 20-year period, and be sustained through natural regeneration. (USFWS, 2019)

**Recovery Actions:**
- Maintain the current geographic distribution of the species through maintaining habitat integrity. There is only 1 known native population of Hackelia venusta, of about 572 to 772 plants, covering approximately 16 hectares (40 acres). Because there are threats from the presence of the nearby State highway, continuing and increasing coordination between the U.S. Forest Service and the Washington Department of Transportation will be necessary. Planning for the future maintenance of this habitat is essential to facilitate the timely implementation of recovery actions. (USFWS, 2007)
- Continue surveys in Tumwater Canyon and other appropriate areas; identify potential habitat for reintroductions.  Although considerable inventory work has been undertaken for this species, the discovery in the last few years of previously unknown sites, and the highly convoluted terrain of the Wenatchee Mountains, suggests that other populations may yet be discovered. (USFWS, 2007)
- Establish if necessary, new populations of H. venusta within the estimated historical range of the species. Further field inventory may reveal previously unknown  populations which meet the criteria for recovery. If so, reintroduction efforts will not be necessary. However, if no other large populations are found through further inventory work, reintroduction may be necessary to ensure the viability of the taxon into the foreseeable future. A carefully prepared reintroduction plan and propagation and reintroduction research will be necessary before reintroduction is undertaken. Reintroduction may only take place in the Tumwater Canyon watershed, which is the only watershed known to have supported populations of the species, based on historical collections. Based on habitat surveys to date, there appear to be few locations suitable for reintroduction having all habitat attributes necessary to

support H. venusta. (USFWS, 2007)

- Collect seed adequately representing the genetic diversity within the species and store in a Center for Plant Conservation approved facility. The single known population, small number of individuals, and extremely restricted distribution of Hackelia venusta make this species highly vulnerable to random environmental and human-caused events. As a hedge against the loss of significant genetic material, seed representing the diversity within the taxon should be collected and stored in at least one Center for Plant Conservation approved facility. The stored seed could also be used in efforts to establish new populations. Periodic testing will be necessary to estimate the rate of viability loss of stored seed. This will help estimate the correct interval and adequate quantity of seed to recollect for storage. (USFWS, 2007)
- Establish a technical working group to periodically review the status of the species and assess the effectiveness of management plans and other recovery actions. Annual review of all progress toward recovery and all ongoing research and monitoring is critical for successful implementation of this plan and for modifications to the plan that may be needed in future. (USFWS, 2007)
- Determine the suitability for establishing appropriate delisting criteria (Priority 3). As more information becomes available over time, the conditions necessary for delisting Hackelia venusta should become apparent. (USFWS, 2007)
- Recommendation for Future Actions from 2011 5-Year Review: Continue efforts for establishing additional populations of H. venusta. This work will require refining propagation and reintroduction methods, and continuing to search for potential sites for outplanting the species. This includes continuing to collect and store genetically representative samples of seeds and determining optimal germination requirements. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Dr. Darlene Zabowski, Soil Science Professor at the University of Washington, has proposed a study of soil requirements for H. venusta. This study may help to clarify the substrate requirements of this species. As researchers have shown with other species, the success or failure of small outplantings in different sites may also provide a useful indicator of habitat requirements for the species (Dunwiddie 2010, Lawrence and Kaye 2009), Taylor 2008, WNHP 2007). (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: As the next step in monitoring, it would be useful to establish a yearly record of temperature, rainfall, and soil moisture. Together with annual pollinator censuses and assessments of the general condition of plants, it might then be possible to find patterns of pollinator abundance or scarcity, and relate them to seed set on H. venusta in the context of environmental conditions. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue the examination of life history: reproductive/pollination biology, seed production, germination requirements, seedling establishment, life span. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Investigate the natural history of H. venusta - What was its potential historic range? Could the white-flowered population have been at higher elevations at one time? (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue to study the effects road de-icer formulas have on H. venusta. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Resolve the taxonomy of H. venusta and H. “taylori” and provide an appropriate name for these high elevation plant

populations of conservation concern. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue work to improve the existing population and reduce the threats to the species sufficient to accomplish increases in population size and geographic distribution across its presumed historical range so that the species is no longer in danger of extinction. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue investigations for potential suitable habitat for H. venusta to find potential reintroduction sites, with emphasis on studying sites that have been found to be promising such as Icicle Canyon, and other sites within a two miles radius of the extant site. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future research and management recommendations include: (1) Develop an improved monitoring plan for the core population and outplantings that is replicable and minimizes impacts. (2) Research potential outplanting sites, and potential sites where undiscovered populations may occur. (3) Establish additional populations to meet downlisting and delisting criteria. (4) Monitor for the threat of invasive Mogulones cruciger in Washington and near Hackelia venusta sites. (5) Continue to supplement core and outplanting sites with plants until populations are self-sustaining (USFWS, 2020)

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# SPECIES ACCOUNT: *Harrisia (=Cereus) aboriginum (=gracilis)* (Aboriginal Prickly-apple)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Harrisia aboriginum is a sprawling cactus, usually with multiple stems arising from a single base. The stems are erect, slender, and cylindrical. They possess 9 to 11 longitudinal ribs, and may reach 6 m (20 ft) in height. Spines are 1.0 cm (0.4 in) long and originate in clusters of 7 to 9 spines, with up to 20 spines in a cluster at the base of the stem. Flowers are funnel-shaped, white, up to 18 cm (7.1 in) long; have a slight scent; and are nocturnal, lasting only one night. The bracts on the outside of the flower has sparse white hairs. Fruits are yellow, round in shape, and 6.1 to 7.6 cm (2.4 to 3.0 in) in diameter. (USFWS, 2013)

**Taxonomy**

Harrisia aboriginum (Family: Cactaceae) was described by John Kunkel Small, after he discovered it in Manatee County in 1919. The most recent revision of the genus Harrisia supports H. aboriginum as a morphologically and genetically distinct species endemic to the west coast of Florida (USFWS, 2013).

**Historical Range**

Harrisia aboriginum was known historically from coastal areas of southwest Florida along the Gulf coast in Manatee, Charlotte, Sarasota, and Lee Counties. The species was documented on six keys along approximately 125 km (78 mi) of Gulf of Mexico coastline (USFWS, 2013).

**Current Range**

Currently occurs along the Gulf Coast of Florida, in Sarasota, Lee, and Charlotte Counties (NatureServe, 2015).

**Critical Habitat Designated**

Yes; 2/22/2016.

**Legal Description**

On January 22, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 22, 2016) for Harrisia aboriginum (Aboriginal Prickly-apple) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Florida (81 FR 3866-3925).

**Critical Habitat Designation**

The critical habitat designation for Harrisia aboriginum includes eleven CHUs in Manatee, Charlotte, Sarasota, and Lee Counties, Florida. This species' critical habitat encompasses approximately 3,444 acres (ac) (1,394 hectares (ha)). Nine of these units (approximately 44 percent of the area) were occupied by the species at the time of listing; the remaining two units (approximately 56 percent of the area) were unoccupied. The critical habitat includes lands under Federal (11 percent), State (48 percent), county (15 percent), and private or other (26 percent) ownership. General descriptions are presented below. Maps depicting the CH units are available in the Final Rule (81 FR 3866-3925).

Unit APA1: Terra Ceia, Manatee County, Florida: Unit APA1 consists of approximately 222 ac (90 ha) in Manatee County, Florida. This unit is composed of State lands within Madira Bickel Mound State Historical Park, Terra Ceia Preserve State Park, Cockroach Bay State Buffer Preserve, and the Tampa Bay Estuarine System (66 ac (27 ha)); Manatee County lands at Emerson Point Preserve and parcels owned by the Manatee County Port Authority (70 ac (28 ha)); and parcels in private or other ownership (87 ac (35 ha)). This unit includes lands west of Highway 41 extending from just south of South Dock Street south to Snead Island. The unit also includes areas of Harbor Key, Mariposa Key, Horseshoe Key, Joe Island, Skeet Key, Paradise Island, Ed's Key, and Rattlesnake Key.

Unit APA2: Longboat Key, Sarasota County, Florida: Unit APA2 consists of approximately 54 ac (22 ha) in Sarasota County, Florida. This unit is composed entirely of parcels in private or other ownership. This unit includes lands west of Gulf of Mexico Drive, extending from 0.40 mi (0.6 km) south of the intersection of Bay Isles Parkway and Gulf of Mexico Drive, to the southern tip of Longboat Key. It also includes lands on the north side of Gulf of Mexico Drive, east of Longboat Club Key Drive, on the northwest tip of Longboat Key.

Unit APA3: Osprey, Sarasota County, Florida: Unit APA3 consists of approximately 116 ac (47 ha) in Sarasota County, Florida. This unit is composed of Sarasota County lands within Palmer Point County Park (50 ac (20 ha)) and parcels in private or other ownership (66 ac (27 ha)). This unit extends along the barrier island (Casey Key) from the south terminus of Blind Pass Road, south for approximately 1.2 mi (1.9 km) along North Casey Key Road. On the mainland, the unit includes lands bordered on the north by Vamo Way, to the east by Highway 41, and to the south by Palmetto Avenue.

Unit APA4: Manasota Key, Sarasota and Charlotte Counties, Florida: Unit APA4 consists of approximately 415 ac (168 ha) in Sarasota and Charlotte Counties, Florida. This unit is composed of State lands within Stump Pass Beach State Park (58 ac (23 ha)); County lands within Blind Pass Park, Brohard Beach and Paw Park, Manasota Beach Park, Casperson Beach Park, and Service Club Park (111 ac (45 ha)); and parcels in private or other ownership (245 ac (99 ha)). This unit extends from Beach Road in the City of Venice, south along Manasota Key to the barrier islands southern tip, including a portion of Peterson Island.

Unit APA5: Charlotte Harbor, Charlotte County, Florida: Unit APA5 consists of 51 ac (21 ha) in Charlotte County, Florida. This unit is composed entirely of State lands within the Charlotte Harbor Preserve State Park. This unit includes the Big Mound, Boggess Ridge, and a shell mound located on the east side of Charlotte Harbor, south of the City of Charlotte Park.

Unit APA6: Gasparilla North, Charlotte and Lee Counties, Florida: Unit APA6 consists of approximately 98 ac (40 ha) in Charlotte and Lee Counties, Florida. This unit is composed of State land (0.006 ac (0.02 ha)), county land (22 ac (9 ha)), and parcels in private or other ownership (77 ac (31 ha)). This unit includes most of Kitchen Key (Live Oak Key) and the area east of Gasparilla Road, from the intersection of Grouper Hole Road and Grouper Hole Court, south to 0.15 mi (0.24 km) north of Snail Island Court, from approximately 0.10 mi (0.21 km) south of 35th Street to 23rd Street, including the small island separated from Gasparilla Island by a canal; and from

22nd Street to 20th Street.

Unit APA7: Gasparilla South, Lee County, Florida:  Unit APA7 consists of approximately 92 ac (37 ha) in Lee County, Florida. This unit is composed of Federal land owned by the Service and Bureau of Land Management (3 ac (1 ha)), State lands within Gasparilla Island State Park (69 ac (28 ha)), Lee County lands (12 ac (5 ha), and parcels in private or other ownership (8 ac (3 ha)). This unit includes lands located from south of 1st Street to the southern tip of Gasparilla Island.

Unit APA8: Cayo Pelau, Charlotte and Lee Counties, Florida:  Unit APA8 consists of approximately 25 ac (10 ha) in Charlotte and Lee Counties, Florida. This unit is composed of Lee County lands within Cayo Pelau Preserve, and parcels in private or other ownership (0.6 ac (0.2 ha)). This unit includes lands located from 0.13 mi (0.21 km) south of the northern tip of Cayo Pelau, extending south to the southeastern tip of Cayo Pelau.

Unit APA9: Cayo Costa, Lee County, Florida:  Unit APA9 consists of approximately 1,702 ac (689 ha) in Lee County, Florida. This unit is composed of State lands within Cayo Costa State Park (1,379 ac (558 ha)), lands owned by Lee County (94 ac (38 ha)), and parcels in private or other ownership (230 ac (93 ha)). This unit includes lands located from the northern tip to the southern tip of Cayo Costa.

Unit APA10: Bocilla, Lee County, Florida:  Unit APA10 consists of approximately 33 ac (13 ha) in Lee County, Florida. This unit is composed of Lee County lands within the Bocilla Preserve (32 ac (13 ha)) and parcels in private or other ownership (0.7 ac (0.3 ha)). This unit includes lands located on the undeveloped portion of Bokeelia Island from 0.02 mi (0.03 km) west of the terminus of Ebbtide Way, extending south and west to the northwestern and southeastern corners of Bokeelia Island.

Unit APA11: Sanibel Island and Buck Key, Lee County, Florida:  Unit APA11 consists of approximately 635 ac (257 ha) in Lee County, Florida. This unit is composed of Federal lands owned by the Bureau of Land Management, and Service lands within the J.N. `Ding' Darling National Wildlife Refuge (NWR) (373 ac (151 ha)), State lands (47 ac (19 ha)), lands owned by Lee County (90 ac (36 ha)), and parcels in private or other ownership (126 ac (51 ha)). This unit includes lands on Buck Key, Runyan Key, and Sanibel Island. On Sanibel Island, the unit includes a portion of Bowman's Beach, from just south of Silver Key to the western terminus of Water's Edge Lane; uplands within J.N. `Ding' Darling NWR; and a shell mound located near the northern terminus of Tarpon Bay Road.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation.  The PCEs of Harrisia aboriginum critical habitat consists of the following components (81 FR 3866-3925):

(i) Areas of upland habitats consisting of coastal berm, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse, calcareous, and storm-deposited sediment. (B) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil covering limestone or organic matter that accumulates on top of the limestone. (C) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) A plant community of predominately native vegetation with no invasive, nonnative animal or plant species or such species in quantities low enough to have minimal effect on survival of Consolea corallicola.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient size to sustain viable populations in coastal berm, rockland hammocks, and buttonwood forest.

(v) Habitats that provide populations of the generalist pollinators that visit the flowers of Consolea corallicola.

**Special Management Considerations or Protections**

Management considerations or protection are necessary throughout the critical habitat units to avoid further degradation or destruction of the habitat that provides those features essential to the species' conservation. The primary threats to the physical or biological features that Harrisia aboriginum depends on include: (1) Habitat destruction and modification by development and sea level rise; (2) Competition with nonnative, invasive plant species; (3) Herbivorous nonnative animal species; (4) Wildfire; and (5) Hurricanes and storm surge. Some of these threats can be addressed by special management considerations or protection while others (e.g., sea level rise, hurricanes, storm surge) are beyond the control of landowners and managers. However, even when landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats. Management activities that could ameliorate these threats include the monitoring and minimization of impacts from recreational activities, nonnative species control, and protection from development. Precautions are needed to avoid the inadvertent trampling of Harrisia aboriginum in the course of management activities and public use. Development of recreational facilities or programs should avoid impacting these habitats directly or indirectly. Ditching should be avoided because it alters the hydrology and species composition of these habitats. Sites that have shown increasing encroachment of woody species over time may require efforts to maintain the open nature of the habitat, which favors these species. Nonnative species control programs are needed to reduce competition, predation, and prevent habitat degradation. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All critical habitat units require active management to address the ongoing threats above and those presented in the Summary of Factors Affecting the Species sections in the proposed and final listing rules. The Service, State of Florida, and Manatee, Sarasota, Charlotte, and Lee Counties own and manage conservation lands within the historical range of Harrisia aboriginum. The CCP for J.N. 'Ding' Darling National Wildlife Refuge (JDDNWR) promotes the enhancement of wildlife populations by maintaining and enhancing a diversity and abundance of habitats for native plants and animals, especially imperiled species. This CCP provides specifically for maintaining populations of H. aboriginum. The State Management Plans for Charlotte Harbor Preserve, Cayo Costa, Stump Pass Beach, DelnorWiggins Pass, and Gasparilla Island State Parks and Bocilla Preserve promote the protection of habitats and native species. The Service, State of

Florida, and Manatee, Sarasota, Charlotte, and Lee Counties conduct nonnative species control efforts on sites that support, or have suitable habitat for, H. aboriginum. The Service monitors the population of H. aboriginum at JDDNWR. FDEP monitors the H. aboriginum population at Charlotte Harbor Preserve State Park. Nonnative species control is currently lacking at Manasota Beach Park and Kitchen Key in areas that support H. aboriginum. Poaching, vandalism, and wildfire have been observed at Manasota Beach Park. Most populations are at elevations close to sea level and may require assisted migration as sea level rise continues to drive the transition toward salt-tolerant plant species in these areas. Reintroduction is needed to restore the species' historical distribution on Cayo Costa and Madira Bickell Mound State Historical Park. Augmentation of small populations at Longboat Key, Terra Ceia, Lemon Bay Preserve, Kitchen Key, Gasparilla Island, and Cayo Pelau would reduce the risk of population loss to hurricanes, storm surge, or wildfire. Harrisia aboriginum is listed on the Regulated Plant Index as endangered under chapter 5B–40, Florida Administrative Code. Florida Statutes 581.185 sections (3)(a) and (b) prohibit any person from willfully destroying or harvesting any species listed as endangered or threatened on the Regulated Plant Index, or growing such a plant on the private land of another, or on any public land, without first obtaining the written permission of the landowner and a permit from the Florida Department of Plant Industry.

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: May - September (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2016)

**Reproduction Narrative**

Adult: Insect visitors recorded on other species of Harrisia include hawk moths (Nitidulidae), stingless bees (Meliponidae), and several types of beetles. Flowers are produced May through September. Ripe fruits have been observed from June through October (USFWS, 2013). Generalist pollinators (e.g., bees, butterflies, and beetles) pollinate H. aboriginum (USFWS, 2016).

**Habitat Type**

Adult: Terretrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal hammocks, shell middens (NatureServe, 2015); tropical savanna: berm, grassland (USFWS, 2013)

**Dependencies on Specific Environmental Elements**

Adult: High sunlight exposure, disturbance regime (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: Dense canopy cover, elevations significantly above sea level (USFWS, 2016)

**Spatial Arrangements of the Population**

Adult: Linear (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Open coastal hammocks and shell middens at low elevations. This species has a narrow environmental specificity (NatureServe, 2015). The climate of south Florida where Harrisia aboriginum occurs is classified as tropical savanna. Harrisia aboriginum occurs in coastal berm, coastal strand, coastal grassland, and maritime hammock. It also occurs on shell mounds with a calcareous shell substrate (Bradley et al. 2004, pp. 4, 14) (USFWS, 2013). Harrisia aboriginum requires adequate rainfall and does not tolerate freezing temperatures. Substrates supporting Harrisia aboriginum include sand and calcareous shell material (Bradley et al. 2004, pp. 4, 14). Harrisia aboriginum requires upland habitats that occur above the daily tidal range, but are potentially subject to flooding by seawater during extreme tides and storm surge. H. aboriginum will not tolerate hydric or saline soils. The species occurs in habitats that have a vegetation composition and structure that allows for adequate sunlight. Disturbance regimes, including hurricanes, and infrequent inundation events that maintain the habitat suitability for H. aboriginum (USFWS, 2016).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Studies on the pollination biology of Harrisia aboriginum are unknown. Insect visitors recorded on other species of Harrisia include hawk moths (Nitidulidae), stingless bees (Meliponidae), and several types of beetles. Harrisia fruits are sweet and fleshy, suggesting that seed dispersal by birds may be important. (USFWS, 2013)

***Population Information and Trends***

**Population Trends:**

Decline of <30% to increase of 25% (NatureServe, 2015)

**Species Trends:**

Relatively stable (NatureServe, 2015)

**Number of Populations:**

12 (USFWS, 2013)

**Population Size:**

300 - 500 (USFWS, 2015)

**Adaptability:**

Low (inferred from USFWS, 2013)

**Population Narrative:**

The long-term population trend is a decline of <30% to an increase of 25%. Recently the species appears to be relatively stable (NatureServe, 2015). In total, the species was represented by an estimated 300 to 500 individuals in 2007, when population sizes were last estimated. The current range of Harrisia aboriginum spans a small geographic area (100-km (62-mi) stretch of coastline north to south). Of 12 extant populations, all but 2 have fewer than 100 plants (USFWS, 2013).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Destruction and modification of habitat from development throughout the species' range continue to be a threat to Harrisia aboriginum. The coastal habitats of this species have been heavily impacted by development over the past 50 years. Despite the recent downturn in residential construction, coastal development is ongoing in the habitat of H. aboriginum. Populations on private land or non-conservation public land are most vulnerable to habitat loss. Threats include residential development, road widening, and landscape maintenance . Suitable habitat within the species' range was recently destroyed by encroachment from a private development onto State land (FNAI 2011, pp. 207–208). The threats of habitat loss, modification, and degradation are expected to increase with increased human population, development pressure, and infrastructure needs. Sarasota, Charlotte, and Lee Counties, where this plant currently occurs, are expected to build out before 2060, placing further pressure on remaining natural areas. Populations located on public lands are better protected than those on private land, but still may face the threat of habitat loss through development of park facilities such as new buildings, parking lots, and trails (USFWS, 2013).

**Stressor:** Poaching (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Overutilization (collection by hobbyists, also known as poaching) is a major threat to Harrisia aboriginum. The rarity of H. aboriginum, coupled with its showy flowers, makes this cacti particularly desirable to collectors. Evidence of poaching was recently observed at a site in Sarasota County that has high public visitation (USFWS, 2013).

**Stressor:** Disease and predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An as yet unidentified pathogen can attack Harrisia aboriginum and cause stems to rot and die within about a week. However, no signs of this disease were observed at several sites visited in 2011. Herbivory of flowers by iguanas (Iguana sp.) and stems by gopher tortoises (Gopherus polyphemus) has been noted. Scale insects have been observed in some H. aboriginum populations, occasionally causing severe damage to plants. Overall, evidence indicates disease and predation are relatively minor stressors to H. aboriginum at present, but could become threats in the future if they become more prevalent in the cacti populations

(USFWS, 2013).

**Stressor:** Fire (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At a site in Sarasota County, a large illegal bonfire pit is located within the habitat that supports one of the larger populations of H. aboriginum. The bonfires occur just a few yards from the plants (Bender 2011, pp. 5–6). At least one plant was killed by an escaped fire that affected part of this site in 2006 (Woodmansee et al. 2007, p. 108), and should another fire escape into occupied habitat in the future, it is reasonable to conclude this could result in the loss of individuals or extirpation of populations (USFWS, 2013).

**Stressor:** Nonnative plant species (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Schinus terebinthifolius can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for Harrisia aboriginum, which prefer moderate to full sun exposure. For example, at more than one site, numerous H. aboriginum plants occurring in the shade of S. terebinthifolius were observed to have died. Casuarina equisetifolia forms dense stands that exclude all other species through dense shade and a thick layer of needles that contain substances that leach out and suppress the growth of other plants. Coastal strand habitat that once supported Harrisia aboriginum has experienced dramatic increases in C. equisetifolia over the past 30 years. Other invasive plant species that are a threat to Harrisia aboriginum include Scaevola taccada (beach naupaka), Neyraudia reynaudiana (Burma reed), Cupaniopsis anacardioides (carrotwood), Thespesia populnea (Portia tree), Manilkara zapota (sapodilla), Hibiscus tiliaceus (hau), and Hylocereus undatus (night blooming cactus).  (USFWS, 2013)

**Stressor:** Vandalism and recreation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Vandalism is a threat to Harrisia aboriginum, and has caused population declines in both species. At a Sarasota County site, the Service has documented numerous H. aboriginum plants that have been uprooted, trampled, and hacked with sharp implements. This population is impacted by people who use the coastal berm and hammock interface to engage in a variety of recreational (including unauthorized) activities as evidenced by a very large bonfire site and vast quantities of garbage, bottles, and discarded clothing.Due to their historic significance and possible presence of artifacts, shell mounds are susceptible to vandalism by artifact hunters. Despite regulations that protect these sites on State lands (Florida Statute 267.13), there is a long history of artifact hunters conducting unauthorized excavation of shell mounds in Florida, including some mounds where Harrisia aboriginum has been found, causing erosion and opening areas for invasion by nonnative plants (USFWS, 2013).

**Stressor:** Small population size and limited distribution (USFWS, 2013)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** The current range of Harrisia aboriginum spans such a small geographic area that all populations could be affected by a single event (e.g., hurricane). Six of the 12 remaining populations have 10 or fewer individual plants. Threats exacerbated by small population size include hurricanes, storm surges, freezing temperatures, recreation impacts, wildfires, and poaching. Due to ongoing and pervasive threats, the number and size of existing populations of this species are probably not sufficient to sustain it into the future (USFWS, 2013).

**Stressor:** Sea level rise (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Downscaled projections suggest that sea level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida. The current occurrences of Harrisia aboriginum at Live Oak Key (1), Gasparilla Island (2), Bokeelia Island (1), Cayo Pelau (1), Lemon Bay Preserve (1), and Buck Key (1) would be inundated by a 1.8-m (5.9-ft) sea level rise, leading to the loss of these populations. Occurrences at Longboat Key (1), North Manasota Key (2–3), and on a coastal berm in Charlotte Harbor Preserve (1) would not be completely inundated, but would experience significant loss and modification of habitat, and what remains would be highly susceptible to further losses to storm surge and salinization (USFWS, 2013).

***Recovery***

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

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

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- The Service; National Park Service (NPS); State of Florida; Manatee, Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments own and manage conservation lands within the range of Harrisia aboriginum (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support Harrisia aboriginum (USFWS, 2013).

**References**

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016

USFWS 2013. Endangered and Threatened Wildlife and Plants

Determination of Endangered Status for Chromolaena frustrata (Cape Sable Thoroughwort), Consolea corallicola (Florida Semaphore Cactus), and Harrisia aboriginum (Aboriginal Prickly-Apple)

Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821.

U.S. Fish and Wildlife Service. 2016. Designation of Critical Habitat for Consolea corallicola (Florida Semaphore Cactus) and Harrisia aboriginum (Aboriginal Prickly-Apple). Final Rule. 81 FR 3866-3925 (January 22, 2016).

Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Consolea corallicola (Florida Semaphore Cactus) and Harrisia aboriginum (Aboriginal Prickly-Apple)

Final Rule. 81 Federal Register 14. January 22, 2016. Pages 3865 - 3925.

USFWS. 2013. Determination of Endangered Status for Chromolaena frustrata (Cape Sable Thoroughwort), Consolea corallicola (Florida Semaphore Cactus), and Harrisia aboriginum (Aboriginal Prickly-Apple)

USFWS. 2013. Endangered and Threatened Wildlife and Plants

# SPECIES ACCOUNT: *Helenium virginicum* (Virginia sneezeweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/03/1998; Northeast Region (R5) (USFWS, 2015)

**Physical Description**

A perennial herb, 7-11 dm tall. Some Missouri plants reach 17 dm in height (Tim Smith, Missouri Dept. of Conservation, pers. comm. 2006). Basal leaves form a rosette and may be broad in the middle tapering toward the ends, but otherwise may appear oblong. Stem leaves are lanceolate and become progressively smaller from the base to the tip of the stem. Stems are winged, wings being continuous with the base of the stem leaves. Flower ray petals are yellow and wedge shaped with three lobes at the ends. Central disk is nearly ball-shaped. Clusters of golden-yellow flower heads bloom from July to September (NatureServe, 2015).

**Taxonomy**

A member of the Ateraceae (Aster family) (USFWS, 2000). Knox et al. (1995) determined that H. virginicum is distinct from H. autumnale morphologically and ecologically. Genetic work by Simurda and Knox (2000) supported treating H. virginicum and a Pomona, Missouri, Helenium sp. as a monophyletic group. Additional genetic work with a larger number of Helenium populations over a broader geographic range strengthened this conclusion and determined a narrow-leaved Helenium autumnale population from the Bruce Peninsula in Ontario, Canada, to be a sister group to the Virginicum group (Simurda et al. 2005) (NatureServe, 2015).

**Historical Range**

It was first found in Augusta County, Virginia, in 1935 (Blake 1936) and the known range was expanded to Rockingham County by C. E. Stevens in 1967 (Roe 1977) (USFWS, 2000).

**Current Range**

As of 2000, 23 populations have been documented in Augusta county and 7 in Rockingham County. Recent studies from a sinkhole pond in southern Missouri suggest that it may represent a disjunct population, but further studies are needed to resolve this (USFWS, 2000).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual: vegetative; sexual: cross-pollination (USFWS, 2000)

**Lifespan**

Adult: 5 years (USFWS, 2000)

**Breeding Season**

Adult: July - October (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, abundant soil moisture, seed bank (NatureServe, 2015)

**Reproduction Narrative**

Adult: Flowers from early July to October, with peak flowering occurring in late July to early August at most sites. The pollination biology has not been studied in detail; however, cursory observations conducted at Kennedy Mountain Meadow suggest that the primary insect pollinators are bees, wasps (Hymenoptera: Apidae, Halictidae, Sphecidae), butterflies (Lepidoptera: Hesperiidae and Lycaenidae, among others), and hoverflies (Diptera: Syrphidae) (C. Williams, pers. obs.). During favorable years at Kennedy Mountain Meadow, approximately one quarter of the population may flower (Knox and Williams 1988). Flowering appears to correlate with water availability during late spring and early summer, a critical period for bolting and flower formation (Knox et al. 1987). Seasonal water fluctuation, particularly inundation, is probably a key factor affecting recruitment and maintenance of populations (J. Knox, unpubl.). For example, extensive periods of inundation during the growing season may greatly limit recruitment and result in high levels of mortality in established plants. Reestablishment of inundation-depleted populations may be facilitated by a soil seed bank; viable seeds can persist in the soil for at least two years (J. Knox, pers. obs.). Thus H. virginicum appears to be a "boom-bust" species in which recruitment is keyed by water fluctuations: population peaks occur in years of abundant soil moisture and troughs in years of excessive and persistent inundation. In addition, seasonal water fluctuations may also modulate populations of co-occurring plants that compete with H. virginicum for space and resources. (NatureServe, 2015). In a nine year demographic field study at one population, plants were found to live up to five years and flower two to three times (Knox 1997). Individual plants identified in the field are nearly always genets (Knox 1997). Research by Messmore and Knox (1997) determined that plants from at least one site have a self-incompatible breeding system (USFWS, 2000).

**Habitat Type**

Adult: Wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Ephemeral pond, wet meadow (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Seasonal inundation (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Shade (USFWS, 2000)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: In Virginia, Helenium virginicum is a wetland plant restricted to shallow, seasonally inundated ponds (which are in or near sinkholes) in Augusta and Rockingham Counties, Virginia (Blake 1936; Roe 1977; Harvill et al. 1986). The pond basins in which this species occurs are usually flooded from January to July. The substrate at most H. virginicum sites consists of poorly drained, acidic, low fertility Purdy silt loams (USDA 1979) underlain by gray clays and dolomitic bedrock (Werner 1966; Rader 1967). The level of disturbance present at the sinkhole ponds includes relatively undisturbed ponds surrounded by forest, more meadow-like habitats around farm ponds actively used by cattle, a backyard seasonal wetland maintained in an open state by the landowner, a seasonally wet mowed lawn, and a seasonal wetland degraded by severe cattle trampling and an ongoing attempt to fill the site. In Missouri it is found on sinkhole pond margins and wet meadows in the Ozark Highlands (Rimer and McCue 2005). The plant has been found to prefer open growing conditions and is found in a variety of sites in addition to the less disturbed sinkholes and wet meadows including rural airports, roadside ditches, and cattle ranches (R. Rimer and J. Summers, pers. comm. 2005). It appears to be less confined to discrete wetlands in Missouri and can occur in a temporarily wet portion of a hayfield or in roadside ditches (Tim Smith pers. comm.) (NatureServe, 2015). Data from one site indicate that H. virginicum is shade intolerant (USFWS, 2000).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Resiliency:**

Resiliency - In VA, 42 percent of the EOs are classified as having excellent to good viability, 32 percent as fair viability, and 26 percent as poor viability. In MO, 43 percent of the EOs are classified as having excellent to good viability, 43 percent as fair viability, and 14 percent as poor viability. Across the species range, 43 percent are classified as excellent to good, 39 percent as fair, and 17 percent as poor. Viability is currently estimated based on the persistence of above-ground plants over time, among other factors like habitat condition and evident threats. However, we now know that populations of adult plants can fluctuate significantly between observations due to the highly variable hydrology of their preferred habitat. In addition, seeds retain high germinability in the seed bank for at least 11 years providing the ability for the species to re-establish populations of flowering plants at sites following periods of unfavorable conditions. The combination of a self-incompatibility reproductive strategy and low gene flow between neighboring populations is cause for some concern regarding reproductive failure if individual populations get so small that there are only a limited number of compatible mates; however, there is no evidence of this occurring thus far in populations that have been observed over the course of 10 to 15 years, including those that have declined due to habitat disturbances. (USFWS, 2020)

**Representation:**

Representation - The species shows a high level of genetic diversity and structuring, while there is evidence of low diversity within populations and low gene flow among populations. In VA, populations in close proximity have been demographically asynchronous in the same year, despite experiencing similar climates and hydrology (Knox 1997, Adams et al. 2005) possibly indicating metapopulation structure. Populations in MO and VA show significant genetic differences indicating high representation for the species. The species has specific habitat requirements like variable hydrology and acidic soils; however, there are multiple circumstances under which those conditions occur including natural sinkhole ponds as well as human made features like roadside ditches, farm ponds, and other depressions or areas that act as seasonal wetlands. The species occurs in three states and four physiographic provinces, adding to its representation. (USFWS, 2020)

**Redundancy:**

Redundancy - At the time of listing (1998), there were 25 known populations in VA and one suspected occurrence in MO. Through additional survey work (and a revision of how EOs are defined), there are currently 76 EOs in 3 states spanning 4 physiographic provinces: 19 EOs in VA, 56 EOs in MO, and 1 EO in IN. Several recovery criteria are no longer relevant due to the increased distribution and number of occurrences. There has been no range contraction among the originally identified populations in VA, and significant range expansion in MO with the discovery of 55 additional EOs. Currently, a large number of populations occur across a broad geographic range, increasing the species' ability to withstand catastrophic events. Redundancy has therefore increased significantly since listing. (USFWS, 2020)

**Number of Populations:**

26 - 30 (USFWS, 2000)

**Population Size:**

10,000 - 100,000 individuals (NatureServe, 2015); 1 - 500,000 per occurrence (USFWS, 2000)

**Population Narrative:**

Species exhibits high tolerance to mechanical disturbance. Surprisingly, it appears to benefit from grazing. The stems and leaves of this species are extremely bitter in taste and apparently unpalatable, thus selective grazing by cattle may eliminate competing plants (John Knox, pers. obs.). Moreover, the largest (100,000 - 1,000,000 plants) and densest H. virginicum population (> 400 plants/m2) grows at a site that is mowed yearly. The estimated population size in Virginia is 2500-10,000; in Missouri over 10,000. Widely fluctuating population numbers have been taken into consideration: a population of 10,000 one year may be reduced to a handful in years of drought or prolonged inundation. The long term population trend is unknown (NatureServe, 2015). As of 2000, 30 populations have been documented, four of which have not been seen since the late 1970's and may be locally extirpated. Population sizes documented among the different occurrences range from one individual to 500,000 (USFWS, 2000). In summary, the best available information currently indicates the existence of 76 EOs of H. virginicum across 3 states; this represents a significant increase in spatial distribution (redundancy, representation) and abundance (resilience) from the 25 known populations in 2 counties in VA at the time of listing. As discussed in more detail below in section 2.3.1.3, it also represents a significant increase in genetic diversity (representation) since Knox (2016) reported all sampled populations as being genetically distinct. The following sections provide more detailed information on abundance estimates in each state. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (NatureServe, 2015)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.). The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000): The most serious threat to H. virginicum appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported H. virginicum and so loss of some habitat has occurred. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. A variety of site-specific threats to H. virginicum from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. Another H. virginicum population is near the site of silos built in the early 1990's that are used to store septic waste. Mowing occurs in at least 3 of the Virginia sites. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted. As the soils of the H. virginicum sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species (NatureServe, 2015).

**Stressor:** Nonnative species (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Exotic organisms may pose threats to H. virginicum populations in the near future. Purple loosestrife, L. salicaria, is slowly spreading through Virginia and may eventually invade some H. virginicum sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, L. dispar, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact H. virginicum populations. For example, as H. virginicum is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow H. virginicum to expand into areas from which it was formerly excluded (NatureServe, 2015).

**Stressor:** Stochastic events (USFWS, 2000)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Extremes in the fluctuating hydroperiod of the ponds could, when preceded by a low investment in the seed bank, result in local extirpations of populations. The self-incompatible breeding system may eventually lead to local extinction at sites with low population numbers

(Messmore and Knox 1997) (USFWS, 2000).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 2

**Delisting Criteria:**
1. Twenty self-sustaining populations and their habitats have received permanent protection across the species' Virginia range (USFWS, 2000).

2. Monitoring over a 15-year period indicates that populations in the 20 sites are viable (USFWS, 2000).

3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 2000).

4. Seeds representing the range of genetic diversity in H. virginicum are placed in long-term storage to provide a source of genetic material in the event of extinction (USFWS, 2000).

5. If determined to be H. virginicum, the Missouri population and its habitat are permanently protected and seeds placed in long-term storage (USFWS, 2000).

**Recovery Actions:**
- Protect the extant populations and their habitat (USFWS, 2000).
- Monitor extant populations (USFWS, 2000).
- Definitively identify the range and distribution of the species (USFWS, 2000).
- Continue investigations into the life history and ecology of Helenium virginicum (USFWS, 2000).
- Maintain seed sources for the species (USFWS, 2000).
- Develop informational materials to create more awareness of H. virginicum and its status (USFWS, 2000).
- H. virginicum has been listed as endangered by the Commonwealth of virginia since 1989 under the Endangered Plant and Insect Species Act. This law protects listed plant and insect species from take in the form of collection or translocation, except by the landowner (USFWS, 2000).
- Site-specific conservation planning, funded by the U.S. fish and Wildlife Service and the Virginia Department of Agriculture and Consumer Services, was conducted by the Virginia Department of conservation and Recreation's Division of Natural Heritage at five privately-owned sites (Erdle 1996, Erdle 1997) (USFWS, 2000).
- If the Missouri Helenium sp. is confirmed to be H. virginicum, sinkhole pond habitat in Missouri, intervening states, and other areas of virginia will need to be targeted for surveys to determine the distribution of this species (USFWS, 2000).
- A fact sheet on H. virginicum was developed by the Virginia Department of Conservation and Recreation's Division of Natural Heritage in 1995 (USFWS, 2000).

- Six of the sites that have been documented to support populations of H. virginicum are on land managed by the U.S. Forest Service (USFWS, 2000).
- A number of studies are underway or planned for the near future by J.S. Knox and associates at Washington and Lee University (USFWS, 2000).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Because we have determined that H. virginicum no longer meets the definition of T or E, the following recommendations are not required to achieve or maintain recovery. They reflect the need for post-delisting monitoring and highlight actions that have already been proposed but not yet carried out and would contribute to our understanding of population genetics for this geographically disjunct species. 1. Develop a post-delisting monitoring plan and continue monitoring EOs for viability over time. a. Develop and implement methodology to survey and monitor the seed bank instead of relying on observations of above ground plants for improved viability estimates. 2. Conduct surveys in IN in suitable habitat near the EO in Hamilton County. In addition, complete genetic analysis of the IN EO to help determine whether it is a natural or introduced occurrence. 3. Opportunistically collect seeds from VA populations,additional MO populations, and IN populations if more are discovered, representing adequate genetic diversity and place them in long-term storage. 4. Conduct additional genetic analysis with larger sample sizes from VA and MO populations using both contemporary plants and seed bank samples. (USFWS, 2020)

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# SPECIES ACCOUNT: *Helianthus paradoxus* (Pecos (=puzzle, =paradox) sunflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/20/1999; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

An annual herb with stems 1-2 m tall. Flower heads have yellow rays and are 3-5 cm across (NatureServe, 2015).

**Taxonomy**

Puzzle sunflower is a species of hybrid origin (Rieseberg et al. 1990; Rieseberg 1991). The parental species are the common sunflower and the prairie sunflower, H. petiolaris. These two species occupy different habitats from puzzle sunflower (NatureServe, 2015).

**Historical Range**

Historically there were six other locations within Pecos and Reeves Counties; however all except one of these sites have not been relocated due to imprecise locality data and the lack of access to private land. The relocated site was heavily invaded by salt cedar and had little water left. No puzzle sunflowers were found, although the entire site was not searched (NatureServe, 2015).

**Current Range**

At present puzzle sunflower occurs in two general areas in Pecos and Reeves Counties in west Texas and four general areas in New Mexico (NatureServe, 2015). Pecos sunflower populations occur at alkaline wetlands in the arid regions of west Texas, lower Pecos River of eastern New Mexico, and the Rio Grande and Rio San Jose of west-central New Mexico (USFWS, 2015).

**Critical Habitat Designated**

Yes; 4/1/2008.

**Legal Description**

On April 1, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Helianthus paradoxus (Pecos (=puzzle, =paradox) sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in New Mexico and Texas (73 FR 17762-17807).

**Critical Habitat Designation**

The critical habitat designation for Helianthus paradoxus includes five CHUs (ten sub-units) in Chaves, Cibola, and Guadalupe counties, New Mexico, and in Pecos County, Texas. This species critical habitat encompasses approximately 1,305 acres (ac) (528 hectares (ha)) (73 FR 17762-17807).

Unit 1: West-Central New Mexico: Subunit 1a is located at Rancho del Padre Spring Cienega. This subunit is 26 ac (10 ha) in Cibola County, New Mexico. The subunit consists of an area of Rancho del Padre Spring Cienega from the spring on the south side of I– 40 then northeast approximately 0.5 mi (0.8 km) to the Rio San Jose. This population consists of large patches of several thousand plants on areas owned by two private landowners (23 ac (9 ha)) and the Pueblo of Acoma (3 ac (1 ha)). This site was known to be occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by H. paradoxus on every visit (Sivinski 2007a, p. 3). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during H. paradoxus's growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Subunit 1b is located at Grants Salt Flat Wetland. This subunit is 63 ac (25 ha) of private land in Cibola County, New Mexico. The subunit consists of an area of wet alkaline playa (i.e., a seasonal, shallow desert lake) between railroad tracks and I–40 and west of Hwy 122 (Road from Interstate to downtown Grants). Playas are nearly level areas at the bottom of undrained desert basins that are sometimes covered in water. This population consists of large patches of several thousand plants mostly on private property. This site was occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by Helianthus paradoxus on every visit (Sivinski 2007). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by wetland filling and development, encroachment by nonnative vegetation, and livestock management not compatible with H. paradoxus physiology. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Subunit 1c is located at the Pueblo of Laguna. This subunit's acreage is undefined in Valencia County, New Mexico. The subunit consists of an area along the Rio San Jose, South Garcia, New Mexico. At this site, Helianthus paradoxus plants are located in patches at springs along the Rio San Jose. Each patch consists of several hundred to several thousand plants, and a few scattered plants grow along the river (Sivinski 1995, p. 4). The entire site belongs to the Pueblo of Laguna. This site was occupied at the time of listing, is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, encroachment by nonnative vegetation, and livestock grazing during H. paradoxus' growing and flowering season. The Pueblo has developed a management plan for H. paradoxus. On the basis of this plan and our partnership with the Pueblo of Laguna, we are excluding this area from the final critical habitat designation pursuant to section 4(b)(2) of the Act (see ''Application of Section 4(b)(2) of the Act'' section below for additional information).

Unit 2: La Joya Wildlife Management Area: Unit 2 is located in the La Joya Wildlife Management Area. This unit is 854 ac (346 ha) in Socorro County, New Mexico. This population is located about 7 mi (11 km) south of Bernardo within Socorro County near the confluence of the Rio Grande and the Rio Puerco. The La Joya population is bounded to the west by I–25 and to the east by the Unit 7 Drain. The north boundary is adjacent to River Mile 126 of the Rio Grande and the south boundary is adjacent to River Mile 123. One of the largest populations of Helianthus paradoxus occurs adjacent to the Rio Grande at La Joya. This Rio Grande population consists of 100,000 to 1,000,000 plants and occurs on the La Joya Wildlife Management Area (Service 2005, p. 4). It is within the La Joya Unit of the Ladd S. Gordon Waterfowl Complex. This property is owned by the New Mexico State Game Commission. It is managed by the NMDGF for migratory waterfowl habitat, which is compatible with preservation of wetlands for H. paradoxus. We believe this area was not occupied at the time of listing. It was discovered in 2004. This site has been found to be occupied every year since then and represents one of the largest populations of Helianthus paradoxus in the range of the species (Hirsch 2006, p. 1). This unit is currently occupied by a stable population (Blue Earth Ecological Consultants, Inc. 2007c, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, very large population of Helianthus paradoxus, and is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event because it is the sole representative located in an area distinct from any other population in the range of the species. As such, it may contain genetic variation not found anywhere else in the range of the species. Because the water source for this population is stable, this population can be expected to persist in very large numbers every year. As described below, we are excluding Unit 2, the La Joya Wildlife Management Area, from the critical habitat designation for Helianthus paradoxus (see ‘‘Exclusions Under Section 4(b)(2)’’ section).

Unit 3: Santa Rosa: Subunit 3a is located at Blue Hole Cienega/Blue Hole Fish Hatchery Ponds. This subunit is 134 ac (54 ha) in Guadalupe County, New Mexico. The Blue Hole Fish Hatchery Ponds population of Helianthus paradoxus is part of the same population as and nearly contiguous with the Blue Hole Cienega in Santa Rosa, New Mexico. The Blue Hole Fish Hatchery Ponds population is immediately north of Blue Hole Road and the Blue Hole Cienega is immediately south. This subunit was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the subunit to be occupied by Helianthus paradoxus on every visit (Sivinski 2007a, p. 2). This subunit is currently occupied (Blue Earth Ecological Consultants, Inc. 2006, p.1), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. The part of this population at Blue Hole Cienega consists of 100,000 to 1,000,000 plants and is the largest population of Helianthus paradoxus in the upper Pecos River basin. A nontraditional section 6 grant was awarded to the State of New Mexico in 2004 for acquisition of the Blue Hole Cienega, which was finalized in July 2005. At this site, shallow ground water seeps to the surface to create cienega communities. This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment by nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. The part of this population at the Blue Hole Fish Hatchery Ponds is owned and administered by the City of Santa Rosa and consists of approximately 1,000 plants. This site is maintained as a recreational area. City of Santa Rosa park maintenance staff have voluntarily stopped mowing and cutting Helianthus paradoxus during the months of August and September. An information kiosk on endangered wetland plants is being planned for the bike/foot path along the creek at Blue Hole Park. This subunit was confirmed to be occupied in 2006 (Blue Earth Ecological Consultants, Inc. 2006, p. 4), contains all of the PCEs, and is threatened by encroachment from nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address Helianthus paradoxus in this area. Subunit 3b is located at Westside Spring. This subunit is 6 ac (3 ha) of private land in Santa Rosa, Guadalupe County, New Mexico. The subunit consists of an area along an unnamed spring on the west side of the Pecos River, located to the west of River

Road and 1 mi (1.6 km) east of Highway 54. We believe this area was not occupied at the time of listing. It was discovered in 2005, and contained thousands of plants. This site was found to be occupied again in 2006 by a species expert observing from a public right-ofway (Sivinski 2007). This subunit is currently occupied by a stable population, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and encroachment of nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address Helianthus paradoxus in this area. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, large population of Helianthus paradoxus, and is one of only two stable, large populations in Unit 3. This subunit is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event that could occur to the other subunit in Unit 3. It may also contain genetic variation specific to this Unit. Because the water source for this population is stable and not anticipated to be subject to any known future water withdrawals, this population can be expected to persist in large numbers every year.

Unit 4: Roswell/Dexter:  Subunit 4a includes 576 ac (233 ha) of Bitter Lake National Wildlife Refuge and City of Roswell land located in Chaves County, New Mexico. This subunit is located approximately 5 mi (8 km) northeast of the city of Roswell. One of the largest Helianthus paradoxus populations occurs on the Bitter Lake National Wildlife Refuge in New Mexico on Federal lands managed by the Service. Several hundred thousand to a few million plants occur nearly continuously along the shores and small islands of all the artificial lakes in the southern unit of the refuge. Also, a few small patches of plants occur on the west side of Bitter Lake Playa and adjacent springs on the Lost River. This area was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by Helianthus paradoxus on every visit (Ulibarri 2006a, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This area is currently occupied, contains all of the PCEs essential to the conservation of the species, and is threatened by water withdrawal and encroachment of nonnative vegetation. Additional threats occurring on the City of Roswell lands include wetland filling and development, and incompatible livestock management. Therefore, special management or protections may be required to minimize these threats. Subunit 4b includes 96 ac (39 ha) of land within the Bitter Lake National Wildlife Refuge Farm (Refuge Farm). This subunit is located in Chaves County, New Mexico, approximately 5 mi (8 km) east of Roswell on the west side of the Pecos River. Subunit 4b consists of a few large patches with several thousand plants on alkaline seeps behind the dikes on the western edge of the Refuge Farm south of Highway 380. This land is owned and managed by the Service as a grain farm and feeding area for migratory birds. The eastern portion of the Refuge Farm is a marshy spring-seep area that contains a large population of Helianthus paradoxus. The wet soils in this population are not cultivated. This area was known to be occupied at the time of listing and has been visited by species experts during four or more seasons. The experts found the site occupied by Helianthus paradoxus on every visit (Ulibarri 2006b, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This subunit is currently occupied and contains all of the PCEs in the appropriate spatial arrangement and quantity essential to the conservation of the species. Subunit 4c is located at the Oasis Dairy. This subunit is 104 ac (42 ha) of private land in Chaves County, New Mexico. The subunit is located on the east side of Roswell, west side of Pecos River Valley, approximately 4 mi (7 km) southeast of the Hwy 380 bridge, and beside an unnamed spring approximately 0.6 mi (1 km) west of the Pecos River and 6 mi (9 km) south of Highway 380. This site contains a very large, dense patch of several thousand Helianthus paradoxus in a low alkaline sink area approximately 0.5 mi (0.8 km) west of the Pecos River on private land. It also contains a large patch with many thousands of H. paradoxus in a low area below a spring, also on private land. This site was occupied at the time of listing and has been visited by species experts during at least three seasons. These experts found the site occupied by H. paradoxus on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by livestock grazing during H. paradoxus' growing and flowering season, water withdrawal, and wetland filling and development. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Subunit 4d is located at Lea Lake at Bottomless Lakes State Park. This subunit is 20 ac (8 ha) in Chaves County, New Mexico. It includes the wet margins of Lea Lake. This site contains a few thousand plants on the riparian margins of Lea Lake. This land belongs to the State of New Mexico and is managed by the New Mexico Parks and Recreation Division. The lands adjacent to Lea Lake are used as a picnic area and campground for the State Park. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by Helianthus paradoxus on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied (Sivinski 2007a, p. 3; Blue Earth Ecological Consultants, Inc. 2007a, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, and recreational and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Cienega. This subunit is 41 ac (17 ha) of private land in Chaves County, New Mexico. The subunit is located in a small valley west of the Pecos River, east of the Hagerman Irrigation Canal, and 3 mi (5 km) north of Dexter. This site consists of several thousand plants on private land along a wide, boggy drainage bottom. This site was known to be occupied at the time of listing based upon observations from a public right-of-way by species experts during at least three seasons (Sivinski 2007a, p. 2). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during Helianthus paradoxus' growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area.

Unit 5: West Texas Unit 5 includes 240 ac (97 ha) of private land located on Diamond Y Spring in Pecos County, Texas. The unit is located approximately 12 mi (20 km) north-northwest of Fort Stockton, Texas. Unit 5 consists of several hundred thousand to one million plants found on The Nature Conservancy's Diamond Y Spring Preserve and a contiguous parcel of private land. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by Helianthus paradoxus on every visit (Poole 2006, p. 2). This unit is currently occupied (Blue Earth Ecological Consultants, Inc. 2007b, p. 3) and contains all of the PCEs essential to the conservation of the species. The land within The Nature Conservancy's Diamond Y Spring Preserve was purchased to protect Diamond Y Spring Preserve and other rare or endangered aquatic species in the Diamond Y Spring system. This habitat is managed for the conservation of such species (Service 2005, p. 12). Diamond Y Spring Preserve has recently expanded from 1,500 ac (607 ha) to 4,000 ac (1,618 ha). However, Helianthus paradoxus on the Preserve is threatened by water withdrawal occurring outside the

Preserve. On the adjacent private land, H. paradoxus is also threatened by water withdrawal, wetland filling and development, and livestock grazing during the growing and flowering season. As a result, special management or protections may be required to minimize these threats. At this time, we are not aware of any completed management plans that address H. paradoxus in this area.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Helianthus paradoxus critical habitat consists of two components (73 FR 17762-17807):

(i) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone (top 50 cm (19.7 in) of the soil profile), and have salinity levels ranging from 10 to 40 parts per thousand; and

(ii) A low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas occupied by the species at the time of listing contain the physical and biological features essential to the conservation of the species, and whether these features may require special management consideration or protections. As stated in the final listing rule (64 FR 56582), threats to Helianthus paradoxus and its physical and biological features include drying of wetlands from groundwater depletion, alteration of wetlands (e.g., wetland fills, draining, impoundment, and development), competition from nonnative plant species, overgrazing by livestock during H. paradoxus' flowering season, impacts from recreational activities, mowing, and highway maintenance. The loss or alteration of wetland habitat continues to be the main threat to Helianthus paradoxus. The scattered distribution of cienegas makes them aquatic islands of unique habitat in an arid-land matrix (Hendrickson and Minckley 1984, p. 169). There is evidence these habitats have been historically, and are presently being, reduced or eliminated by aquifer depletion, and severely impacted by agricultural activities and encroachment by exotic plants (Poole 1992, pp. 1–2; Sivinski 1995, p. 11). The lowering of water tables through aquifer withdrawals for irrigation and municipal use, diversion of water from wetlands for agriculture and recreational uses, and wetland filling for conversion to dry land uses destroy or degrade desert wetlands. In Grants, New Mexico, Helianthus paradoxus has been observed in close proximity to building sites that may have contained suitable wetland habitat prior to filling (Service 2005, p. 8). A cienega containing H. paradoxus near Dexter, New Mexico, was dried when a wellhead was placed on the spring and the water diverted for other uses (Service 2005, p. 8). Springs that have fed H. paradoxus habitats have been converted to swimming pools and fishing ponds in the towns of Roswell and Santa Rosa, New Mexico (Service 2005, p. 8). Groundwater withdrawals for agriculture in Pecos and Reeves counties in Texas have had an especially severe impact on desert springs (Service 2005, p. 8). Of the 61 historical desert springs in these two counties, only 13 were still flowing in 1980 (Brune 1981 in Poole 1992, p. 5). Beginning around 1946, groundwater levels fell as much as 400 feet (ft) (120 meters (m)) in Pecos County and 500 ft (150 m) in Reeves County. Groundwater pumping has lessened in more recent years due to the higher cost of removing water from deeper aquifers, but rising water tables and resumption of spring flows are not expected (Poole 1992, p. 5). We are not aware of any protections afforded by Texas water law for the remaining springs that support H. paradoxus populations on The Nature Conservancy properties, which limits options for addressing this threat. Livestock will eat Helianthus paradoxus when other green forage is scarce, and when the buds are developing and abundant (Service 1999, p. 56587). Cattle and horses tend to pull off the flower heads, which can reduce seed production (Bush and Van Auken 1997, p. 416). However, well-managed grazing during non-flowering months may have a beneficial effect on H. paradoxus populations by decreasing the density and biomass of potentially competing plant species in these habitats. This sunflower germinates earlier than most associated plants and grows vigorously on wet, bare, highly insolated soils (Service 2005, p. 9). Actions that remove shading grass cover, such as grazing, appear to enhance growth and reproduction of sunflower plants that are later protected from grazing while they are reproductively maturing. Therefore, properly managed livestock grazing can be compatible with H. paradoxus conservation. Livestock grazing operations that are not managed to protect H. paradoxus occur in populations in the Grants and Roswell areas of New Mexico (Service 2005, p. 9). Although water contamination is a significant threat for the Roswell springsnail, Koster's springsnail, Noel's amphipod, and the Pecos assiminea found on Bitter Lake National Wildlife Refuge (70 FR 46304), we have no information on whether contamination of water would affect Helianthus paradoxus. We did not find that reduced water quality was a threat to the species when it was listed in 1999 (64 FR 56582). Moreover, we are not aware of any research or information that documents the species' response to elevated nutrients or contaminants. For these reasons, we do not believe that water contamination is a significant threat to H. paradoxus at this time. We have determined that each area included in this designation meets the definition of critical habitat for the reasons described in our unit descriptions below.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (inferred from NatureServe, 2015)

**Lifespan**

Adult: 1 year (inferred from USFWS, 2015)

**Breeding Season**

Adult: August - October (USFWS, 2015)

**Key Resources Needed for Breeding**

Adult: Possibly ground disturbance (inferred from NatureServe, 2015); pollinators unknown - likely various insects (USFWS, 2005)

**Reproduction Narrative**

Adult: No specific research has been conducted on the reproduction of this species. The reproductive biology is likely to be very similar to that of the common sunflower, H. annuus. Cattle disturbance of the surrounding vegetation may supply puzzle sunflower with light gaps for germination and growth, and lessen competition (Bush and Van Auken 1997). Numerous experiments have been conducted both in and ex situ on competition between puzzle sunflower and its associates (Van Auken and Bush 1993, 1994, 1995). With competitors removed, puzzle sunflower exhibited greater basal stem diameter, more flower heads, and greater flower head, leaf, and stem dry mass (Bush and Van Auken 1997). Annual species of sunflowers hybridize in cultivation, but have reduced pollen viability and seed fertility (Heiser 1965, 1969). Hybrids of puzzle and common sunflower have been observed at Diamond Y Preserve in west Texas and in the Santa Rosa area of New Mexico (NatureServe, 2015). The Pecos sunflower is an annual plant that must re-establish each population by seeds produced during preceding years. It is annual plant that germinates in the spring, and flowers and makes seed from late August through October (USFWS, 2015). Pollination vectors for the Pecos sunflower have not been studied. However, most radiate-headed plants in the aster family are generalists in attracting a variety of insect pollinators (USFWS, 2005).

**Habitat Type**

Adult: Wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Cienega (NatureServe, 2015), wet meadow, spring seeps (USFWS, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Disturbance regime, 10 - 40 ppt soil salinity, < 10% canopy cover (USFWS, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 3,280 - 6,561 ft. elevation (USFWS, 2015)

**Spatial Arrangements of the Population**

Adult: Patches of dozens to thousands (USFWS, 2005)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: Helianthus paradoxus is the only sunflower in the Southwest United States that requires permanent wetlands for its survival. Puzzle sunflowers grow in saline soils that are permanently saturated. Areas that maintain these conditions are commonly called cienegas (desert wetlands) associated with springs. However, the required conditions may also be found at stream margins and at the margins of impoundments. Where plants are associated with the latter the impoundments have replaced the natural cienegas. Van Auken and Bush (1995) tested puzzle sunflower to determine if it was mycorrhizal. The greenhouse experiments, done with non-native soil, indicated that puzzle sunflower was an obligate mycorrhizal species (NatureServe, 2015). This species is associated with spring seeps and desert cienegas, or wet meadows, which are very rare in the dry regions of New Mexico and Texas. The cienega climax community has been described as mid-elevation, 3280.84 to 6561.68 feet (ft.). Disturbance regimes, such as fire or tillage, which eliminate vegetation thatch and expose bare ground surface tend to increase Pecos sunflower cover and productivity (Van Auken and Bush 2004; New Mexico Forestry Division 2008). Based on knowledge of the life history, biology, and ecology of the Pecos sunflower and the habitat requirements for sustaining the essential life history functions of the species, the PBFs for Pecos sunflower are the desert wetland or riparian habitat components that provide: (1) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone in the top 19.69 inches (in) (50 centimeters (cm)) of the soil profile, and have salinity levels ranging from 10 to 40 parts per thousand; and (2) low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant (U.S. Fish and Wildlife Service 2008b). The Pecos sunflower is intolerant of habitats that are too wet at the surface and prefers soils that are relatively dry at the surface and wet in the lower root zone (Bush 2006) (USFWS, 2015). Populations tend to grow in crowded patches of dozens or even thousands of individuals (USFWS, 2005).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2015)

**Dispersal/Migration Narrative**

Adult: Limited seed mobility restricts the ability of the Pecos sunflower to disperse to other suitable habitats or away from habitat that becomes unsuitable (USFWS, 2015).

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Number of Populations:**

7 (USFWS, 2005)

**Population Size:**

< 100 to > 200,000 per site, fluctuates yearly (USFWS, 2015)

**Adaptability:**

Low (inferred from USFWS, 2015)

**Population Narrative:**

At some occurrences it is locally abundant - maybe > 3000 individuals in total - but some New Mexico occurrences are small and nonviable. At present there are six general areas where the species occurs: four in New Mexico and two in Texas. There are between 1 and 11 sites at each of these six general locations for a total of 25 sites. Ten of the 11 Pecos River sites occur within a 22 mile (36 km) stretch of the Pecos River Valley. All eight observations in the Santa Rosa area occur within a four square-mile area. The two sites in Grants are near the San Jose River and separated from the Laguna population by approximately 44 miles (73 km). The two Diamond Y sites are within three miles of each other. The Diamond Y and East Sandia Springs Preserves are within 50 miles (80 km) of each other. The Texas sites are approximately 150 miles (241 km) south of the most southerly New Mexico site. The overall trend for the species is unclear as the historical distribution, with few exceptions, is unknown (NatureServe, 2015). The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations. The number of sunflowers per site varies from less than 100 to several hundred thousand. Because Pecos sunflower is an annual, the number of plants per site can fluctuate greatly from year to year with changes in precipitation and depth to ground water. The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations (USFWS, 2015). Pecos sunflower occurs in seven populations; two occur in west Texas and five are located in New Mexico (USFWS, 2005). The Pecos sunflower is a wetland plant that was known from only a single population near Fort Stockton, Pecos County, Texas, when it was proposed as a candidate for listing as endangered under the Act on December 15, 1980 (45 FR 82480). Subsequent field surveys for this species found additional populations in New Mexico and Texas. At the time of listing, Pecos sunflower was known from 25 sites that occurred in five general areas. These areas were Pecos and Reeves counties, Texas, in the vicinity of Fort Stockton and Balmorhea; Chaves County, New Mexico, from Dexter to just north of Roswell; Guadalupe County, New Mexico, in the vicinity of Santa Rosa; Valencia County, New Mexico, along the lower part of the Rio San Jose; and Cibola County, New Mexico, in the vicinity of Grants. There were three sites in the Fort Stockton to Balmorhea area, eleven in the Dexter/Roswell area, eight in the Santa Rosa area, one along the lower Rio San Jose, and two in the Grants area (Service 1999). In addition, since listing, two new sites on the middle Rio Grande have been added, additional sites at the Ladd S. Gordon Waterfowl Complex, population expansion on BLM land in the Dexter/Roswell area, several new sites in the Santa Rosa area, and expansion of a site in Texas. There are occurrences of Pecos sunflower on State, Federal, tribal land, and several private land holdings (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Reduction of water in springs (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss or alteration of spring habitat continues to be the main threat to Pecos sunflower. Lowering water tables from aquifer withdrawals for irrigation and municipal use has degraded many desert spring habitats. The primary threat to the Pecos sunflower in west Texas is the potential failure of spring flow due to excessive groundwater pumping or drought or both, which would result in total habitat loss for the species. There is evidence that spring habitats have been historically reduced or eliminated by aquifer depletion on the Bitter Lake NWR (Jones and Balleau 1996). In addition, recent drought years may have impacted the size of Pecos sunflower populations on La Joya WMA (Hirsch 2012). Here, the total number of acres occupied by Pecos sunflower fell from 261 ac (105.622 ha) in 2010, to 224 ac (90.65 ha) in 2011, to 200 ac (80.94 ha) in 2012, as the drought in New Mexico intensified (USFWS, 2015).

**Stressor:** Nonnative plants (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Exotic plants have potential to seriously impact the native plant community composition and ecological integrity of arid land springs and cienegas. Exotic trees, especially salt cedar and Russian olive can almost completely convert a treeless cienega to a dense woodland with little understory vegetation. Aggressive, rhizomatous non-native grasses and forbs compete with, and replace, native cienega plants, especially in areas of soil disturbance. Herbaceous

exotics that are currently degrading some arid land springs and cienegas include Persoon (Johnsongrass) (Sorghum halepense), Hudson meadow fescue and perennial pepperweed (USFWS, 2015).

**Stressor:** Water contamination (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Water contamination, particularly from oil and gas operations, could be a potential threat for Pecos sunflower, but the effects on this species have not been studied. In order to assess the potential for contamination, a study was completed in September 1999 to delineate the area that serves as sources of water for the springs on Bitter Lake NWR (Balleau Groundwater, Inc. 1999). This study reported that the sources of water that will reach Bitter Lake NWR's springs include a broad area beginning west of Roswell near Eightmile Draw, extending to the northeast to Salt Creek, and southeast to Bitter Lake NWR. This area represents possible pathways from which contaminants may enter the groundwater that feeds the springs on the Refuge. This broad area is located within a portion of the Roswell Basin and contains a mosaic of Federal, State, City, and private lands with multiple land uses, including expanding urban development. There are 378 natural gas and oil wells in the 12-township area encompassing the source-water capture zone for the Middle Tract of Bitter Lake NWR that are potential sources of contamination (Go-Tech 2010). The Diamond Y Springs Complex is within an active oil and gas extraction field. At this time, there are still many active wells and pipelines located within approximately 330 ft. (100 m) of the surface waters at the springs. In addition, a natural gas refinery is located within 0.5 mi (0.8 km) upstream of Diamond Y Spring (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Increased air temperatures lead to higher evaporation rates, which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge. Increased temperatures across the Southwest may also increase the extent of area influenced by drought (Lenart 2003), decreasing groundwater recharge regionally, and thereby reducing spring discharge. Prolonged drought leading to diminishment or drying of springs would have a negative impact on Pecos sunflower. Springs would not have to dry out completely to have an adverse effect. In addition, as water becomes increasingly scarce, conflict over its use becomes more intense. The proportion of human and livestock consumption of water would be expected to increase during drought. Any of these factors, alone or in combination, could lead to either the reduction or extirpation of Pecos sunflower populations. Therefore, climate change is a significant threat to the Pecos sunflower into the foreseeable future (USFWS, 2015).

**Stressor:** excessive livestock grazing (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** excessive livestock grazing (USFWS, 2023)

**Stressor:** Highway maintenance (USFWS, 2023)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** mowing, and highway maintenance (USFWS, 2023)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8

**Delisting Criteria:**
1. Identify and establish at least one core conservation area for Pecos sunflower in each of the four distinct recovery regions that would collectively, if protected, ensure the long-term survival of the species. Each core habitat must occur on wetlands that are not threatened by depletion of the contributing aquifer and have demonstrated a self-perpetuating stand of Pecos sunflowers of greater than 5,000 individuals for a minimum of 7 out of 10 years. In addition to the core conservation area, each region should have at minimum one isolated stand of protected Pecos sunflowers with greater than 1,600 individuals for at least 7 out of 10 years to protect against catastrophic loss of the regional population (USFWS, 2015).

2. Assure long-term protection of designated core conservation areas and designated isolated stands in perpetuity through the implementation of appropriate management plans, conservation easements, or land acquisitions (USFWS, 2015).

**Recovery Actions:**
- Identify and establish core conservation areas and isolated stands (USFWS, 2005).
- Identify and address information gaps, compatible uses, and management actions regarding Pecos sunflower distribution, biology and aquifer stability (USFWS, 2005).
- Protect core conservation areas and isolated stands through landowner education, implementation of management plans, conservation easements, and land acquisition (USFWS, 2005).
- Monitor Pecos sunflower conservation areas and management actions as needed to satisfy delisting criteria (USFWS, 2005).
- Habitat protection through land acquisition or conservation agreements with landowners is the most important remaining recovery task. The development of management plans for the different agencies, as outlined in the recovery plan, should continue to be pursued. Government programs that acquire cienegas or assist landowners with their management are greatly needed (USFWS, 2015).
- Non-native tree species and thatch should continue to be removed in occupied and potential Pecos sunflower habitats. Pecos sunflowers should be re-seeded in suitable areas with willing land owners or managers within the range of the species to expand occupied habitats. The Pecos sunflower would also make an excellent focal species for public education and awareness of the importance of wetlands and the recovery of listed species. These opportunities should be explored and implemented where appropriate (USFWS, 2015).
- The recovery criteria in the Pecos Sunflower Recovery Plan (U.S. Fish and Wildlife Service 2005) should be collectively re-evaluated to determine if they constitute the most effective

strategy for conservation and recovery of the species. Of most significance, the actual size of existing core populations is between 50 and 100 times, or even higher multiples in some years of, the minimum number required in the recovery plan. The current recovery criteria may not have considered this much higher number of plants extant throughout the range of the species (USFWS, 2015).

- Survey efforts in occupied and potential habitats should be increased and improved, and surveys should employ an agreed-upon standardized protocol. Surveys should cover the entire range of the species and be repeated at least every 3 years. Existing populations should be monitored to document population trends in response to habitat restoration and maintenance (USFWS, 2015).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Continue management actions and encourage partnerships and agreements in the conservation areas of the Recovery Regions with an emphasis on minimization or elimination of threats to core populations, isolated stands, and aquifer security. Research water contamination potential and point and nonpoint source pollutants relative to core and isolated populations. Continue monitoring of the populations in their respective Recovery Regions. This may include analysis of core area mapping for changes in density, continued monitoring on the Overflow wetlands and surrounding BLM lands, the population on the Bernardo Unit of the Ladd S. Gordon Complex, the effects of fire, the water table at Blue Hole Ciénega with a prioritization of the mechanisms regulating groundwater availability, and consider similar monitoring efforts for water availability for populations in Texas. Study the impacts of different types of grazing in the isolated populations of the Recovery Units, and monitor the impacts of feral hogs in the West Texas recovery unit. There is opportunity for cooperation with NMDOT's plans to restore, create or enhance wetlands to benefit Pecos sunflower with excavation, plantings, fencing, natural channel design modifications, and follow-up monitoring (NMDOT 2023) (USFWS, 2023).

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# SPECIES ACCOUNT: *Helianthus schweinitzii* (Schweinitz's sunflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/7/1991; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A perennial herb that produces solitary stems, up to 2 m tall and bears yellow flower heads in late summer and early autumn (NatureServe, 2015).

**Taxonomy**

Heiser et al. (1969), in the most recent monograph of the genus Helianthus, placed H. schweinitzii in Section Divaricati, Series Gigantel. Its closest relatives include other members of the Gigantei series, such as H. giganteus Linnaeus. H. maximiliani Schrader, H. resinosus Small, and H. grosseserratus Martens. The small heads, however, make H. schweinitzii anomalous in the Gigantei (USFWS, 1994).

**Historical Range**

Endemic to Piedmont (and central Plateau) of North Carolina and South Carolina (NatureServe, 2015). Past reports known from other parts of North and South Carolina, including Columbus County. North Carolina, and Horry County, South Carolina (both in the outer Coastal Plain), and Stokes County, North Carolina (in the upper Piedmont of North Carolina near the Virginia border) (USFWS, 1994).

**Current Range**

The species' distribution includes 13 NC counties (the original five plus Anson, Davidson, Gaston, Montgomery, Randolph, Richmond, Stokes, Surry) and two SC counties (Lancaster and York) (USFWS, 2010).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, vegetative (USFWS, 1994)

**Lifespan**

Adult: > 10 years (USFWS, 1994)

**Breeding Season**

Adult: August - first frost (USFWS, 1994)

**Reproduction Narrative**

Adult: It is a long-lived perennial with individuals probably living for decades. The species blooms from late August to frost. The relative importance of sexual (by seed) and asexual (by rhizome) reproduction is not known in this species. Schweinitz's sunflower can also be propagated from pieces of the tubers. New plants readily sprout from entire or partial tubers (Creel, personal communication, 1992) (USFWS, 1994).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Oak-pine-hickory woods, piedmont longleaf pine forests (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full to partial sun (NatureServe, 2015); periodic fire (USFWS, 1994)

**Geographic or Habitat Restraints or Barriers**

Adult: Dense vegetation (USFWS, 1994)

**Spatial Arrangements of the Population**

Adult: Clumped (see population narrative)

**Environmental Specificity**

Adult: Broad (inferred from USFWS, 1994)

**Habitat Narrative**

Adult: Clearings in, and edges of, upland oak-pine-hickory woods and piedmont longleaf pine forests in moist to dryish sandy loams. Requires the full to partial sun of an open habitat, which was formerly maintained over the species' range by wildfires and grazing by herds of bison and elk. Now most occurrences are confined to roadsides and powerline clearings. (NatureServe, 2015). Although H. schweinitzii substrates in the Carolina Slate Belt are primarily mafic rocks (of either volcanic, plutonic, or sedimentary origin), the species also appears to occur on intermediate and even felsic rocks. With fire operating in the landscape to maintain open and semi-open habitats (Piedmont prairies and oak barrens or oak savannas), it is possible that Schweinitz's sunflower had a wider ecological amplitude than is apparent to us in the modern landscape. They also appear to be detrimentally affected by growing in dense competing vegetation, even if the other vegetation does not shade them (Bradford-Clebsch. personal communication. 1992) (USFWS, 1994).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2024)

**Number of Populations:**

94 total, 54 protected (USFWS, 2024)

**Population Size:**

>56,000 (USFWS, 2024)

**Population Narrative:**

Although monitoring for all 90 populations (278 extant EOs) is mostly infrequent and inconsistent, available data does suggest an increase in abundance in populations with potential to provide recovery (24 populations in NC and SC); however, only five populations in NC (representing four counties) and possibly one population in SC (representing one county) are currently of good to excellent viability. Threats identified in the 1990 listing rule and the 2010 5-year review are still current threats. Development pressure remains a significant threat to Schweinitz's sunflower and a TaILS database search yielded 380 consultations associated with the species range-wide since the 2010 5-year review. The Metrolina MSA, which includes York and Lancaster Counties in SC, continues to urbanize. While deer browse is known to be a threat to the species, small mammal and weevil herbivory has also been identified as impacting the species. Populations that are stable or increasing have maintained that status only through active land management to maintain suitable habitat conditions. Accidental herbicide spraying and lack of ROW maintenance impacts the species range-wide. Data and information outlined in this review highlight the need for continued management and consistent monitoring of abundance and threats throughout the range. Schweinitz's sunflower continues to meet the definition of an endangered species under the Endangered Species Act. (USFWS, 2019) Currently, there are 242 occurrence records (EOs and subEOs) in North Carolina that aggregate into 85 extant populations. The North Carolina records also include 17 occurrences with 41 suboccurrences that are classified as extirpated, historical, or failed-to-find. In South Carolina, there are 76 occurrences that aggregate into the 9 populations in the state's database (SCHTP 2023), with 5 occurrences listed as extirpated. Therefore, there are 94 total extant populations for the known range of Schweinitz's sunflower (Figure 1) that collectively contain 56,000 stems (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction and degradation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats to the species continue to escalate with rapid urbanization and suburban sprawl in the greater Charlotte area. Throughout the species' range, over 90% of known sites occur in managed ROW, where vegetation management practices occasionally mimic patterns of natural disturbance (from fire or native grazers) now largely absent from the present day landscape. However, these same vegetation management practices pose a threat to these occurrences, in that inappropriately timed mowing (e.g., during the growing season, prior to seed set) or excessive herbicide application have adversely impacted the species at several of these locations. Many of these ROW occurrences are along existing roads which are subject to widening and improvement projects which disturb or eliminate the existing adjacent ROW. The NCDOT has a program in which roadside occurrences of federally listed plant species are posted with signs prohibiting growing season mowing or herbicide application. Despite these efforts, 28 of 63 NCDOT sites containing H. schweinitzii were reportedly adversely impacted at least once as of 2003 (USFWS, 2010).

**Stressor:** Herbicides (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The two most recent accidental herbicide spraying events involving Schweinitz's sunflower occurred in York County, SC in 2015 and Mecklenburg County, NC in 2018. As a result of these, and similar incidents, Duke Energy is implementing several precautionary measures (Fletcher 2019, Duke, pers. comm.). They are developing an "on-board" Geographic Information System to aid employees and contractors in identifying locations of sensitive habitats and species. In-field employees and contractors, as well as machinery, will be equipped with mobile tablets and mapping software that identifies "red zones" that should not be sprayed or that have specific management requirements. This technology should be in use by spring of 2020. Additionally, in 2018, recovery biologists with the Asheville and Raleigh field offices provided comments and recommendations for updated signage on Duke Energy powerline ROWs and species fact sheets. Installation of updated and new signs, at the sensitive habitat areas, began in the spring of 2019 (a total of 650 signs) and fact sheets are distributed to employees and contractors prior to ROW maintenance activities. The updated signs are in both English and Spanish, and are posted at eye-level. (USFWS, 2019)

**Stressor:** Invasives (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Mowing (wrong season or excessive) (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Native Competition (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Road Construction (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Utility Construction (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:**

**Stressor:** Woody Succession (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

***Recovery***

**Reclassification Criteria:**
1. 10 geographically distinct, self-sustaining populations are protected in at least 4 counties in North Carolina and one in South Carolina (USFWS, 2010).

2. Managers have been designated for each population (USFWS, 2010).

3. Management plans have been developed and implemented (USFWS, 2010).

4. Populations have been maintained for 5 years (USFWS, 2010).

Recovery Priority Number: 2C

**Delisting Criteria:**
1. 15 geographically distinct, self-sustaining populations are protected in at least 4 counties in North Carolina and one in South Carolina (USFWS, 2010).

2. Management plans have been implemented (USFWS, 2010).

3. Populations (as measured by number of adult plants) have been stable or increasing for 10 years (USFWS, 2010).

4. Permanent conservation ownership and management of at least 10 populations are assured by legally binding agreements (USFWS, 2010).

**Recovery Actions:**
- Implement emergency protective management of known remnant populations (USFWS, 1994).
- Survey suitable habitat for additional populations and potential reintroduction sites (USFWS, 1994).
- Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.) (USFWS, 1994).
- Monitor existing populations (USFWS, 1994).
- Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurred (USFWS, 1994).
- Implement management on protected populations (USFWS, 1994).
- For sites with the potential to contribute toward the species' recovery (Appendix B, Tables B.1 and B.2), work with appropriate owners/managers to implement monitoring capable of

producing reliable trend data at each site. Range-wide standardized monitoring protocol are generally not regarded as feasible for this species, due to the widely varying sizes of populations and the resources available to monitor them. However, site-specific protocol could be implemented such that counts or estimates provided at a given site are directly comparable from one monitoring period to the next (USFWS, 2010).

- For sites with the potential to contribute toward the species' recovery (Appendix B, Tables B.1 and B.2), characterize existing vegetation using standardized community classification methods (e.g., NatureServe's community classification systems and Schafale and Weakley (1990)). Use this information to inform restoration objectives and direct future site protection efforts toward the highest quality habitats (USFWS, 2010).
- Devise recovery criteria which balance the availability of suitable habitat with opportunities for restoration, management, and protection as dictated by landowner willingness and resource availability. These criteria should emphasize the role of prescribed fire in site restoration and management, but allow for those instances in which sites cannot be managed with fire (USFWS, 2010).
- Work with Dr. Richard Houk (Winthrop University, retired) to find successors to continue his monitoring efforts in South Carolina (USFWS, 2010).
- Clarify the role of controlled propagation, rescue and relocation, and public demonstration gardens in the species' recovery, so that sites supporting native populations in conjunction with remnants of native plant communities are prioritized for protection (above sites characterized by rescued and introduced plant material) (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTION The 2010 5-year review included a list of recommendations to improve recovery of the species. These actions, listed below, remain applicable to species recovery. For sites with the potential to contribute toward the species' recovery, work with appropriate owners/managers to implement monitoring capable of producing reliable trend data at each site. Range-wide standardized monitoring protocol are generally not regarded as feasible for this species, due to the widely varying sizes of populations and the resources available to monitor them. However, site-specific protocol could be implemented such that counts or estimates provided at a given site are directly comparable from one monitoring period to the next. For sites with the potential to contribute toward the species' recovery, characterize existing vegetation using standardized community classification methods (e.g., NatureServe's community classification systems and Schafale and Weakley (1990)). Use this information to inform restoration objectives and direct future site protection efforts toward the highest quality habitats. Devise recovery criteria which balance the availability of suitable habitat with opportunities for restoration, management, and protection as dictated by landowner willingness and resource availability. These criteria should emphasize the role of prescribed fire in site restoration and management, but allow for those instances in which sites cannot be managed with fire. Work with Dr. Richard Houk (Winthrop University, retired) to find successors to continue his monitoring efforts in South Carolina. Clarify the role of controlled propagation, rescue and relocation, and public demonstration gardens in the species' recovery, so that sites supporting native populations in conjunction with remnants of native plant communities are prioritized for protection (above sites characterized by rescued and introduced plant material). In light of new information, additional future actions are recommended below: Convene a working group of species experts to focus on species recovery. The working group would concentrate on, but not be limited to: o Defining populations, identifying populations on which to focus recovery, and assigning a responsible party for each identified population. o Determining what constitutes a "self-sustaining" population and determining the appropriateness of the criterion for a species dependent on active management. o Developing a standardized, tiered monitoring protocol that could be used on many different types of Schweinitz's sunflower sites. o Determining what constitutes a "natural" habitat considering the species' current relationship to the landscape (i.e. primarily in ROWs). o Clarifying the role of controlled propagation and relocation in recovery o Providing support and, if feasible, pooling resources for management and monitoring. o Prioritizing unprotected sites that are critical for recovery and working towards permanent protection. o Having a regularly scheduled meeting to share resources and information. Support research to determine the geographical extent of Smicronyx pinguis (weevil) and level of threat to Schweinitz's sunflower. Support research to determine if Schweinitz's sunflower is hybridizing with other Helianthus species and to what extent. Encourage Departments of Transportation and utility companies to maintain ROWs in a manner that is beneficial to Schweinitz's sunflower. (USFWS, 2019)

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities The 2010 and 2019 5-year reviews include a list of recommendations to improve recovery of the species. These highlight some recovery activities listed below. • Continue to work with appropriate owners/managers to implement monitoring capable of producing reliable trend data at each site. However, site-specific protocols could be implemented such that counts or estimates provided at a given site are directly comparable from one monitoring period to the next. • For potential reintroduction or restoration sites, characterize existing vegetation using standardized community classification methods (e.g., NatureServe's community classification systems, Schafale (2024) Classification of the Natural Communities of North Carolina). Use this information to inform restoration objectives and direct future site protection efforts toward the highest quality habitats. • Continue coordination of controlled propagation, rescue and relocation, and public demonstration gardens for species' recovery. Consider prioritization of sites supporting native populations in conjunction with remnants of native plant communities prioritized for protection. • Work with species experts to consider: o Defining populations. o Prioritizing populations for recovery. o Determining traits of a "self-sustaining" population. o Developing a standardized, monitoring protocol. o Assisting in management and monitoring. • Support research to enhance conservation efforts and address current knowledge gaps: o Investigate the geographical extent of Smicronyx pinguis (weevil) and its threat level to Schweinitz's sunflower. o Examine whether Schweinitz's sunflower is hybridizing with other Helianthus species. o Assess the performance of the species outside of its current climatic niches across projected novel environments and its threat level. o Expand knowledge on the species' life history, biology, and ecology. • Encourage the Departments of Transportation and utility companies to maintain rights-ofways in a manner that is beneficial to Schweinitz's sunflower (USFWS, 2024).

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# SPECIES ACCOUNT: *Helianthus verticillatus* (Whorled Sunflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/1/2014; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A tall, perennial, herbaceous sunflower 1-2 meters in height with flower heads about 1 cm wide (Matthews et al. 2002). Flowers from August into October (NatureServe, 2015).

**Taxonomy**

The U.S. Fish and Wildlife Service (Call 2009) accepts this taxon as a species in considering it a candidate for federal listing; Matthews et al. (2002) and Flora of North America Editorial Committee (2006) also treat it as a species. Two supporting studies are cited by the USFWS: (1) morphological studies and root-tip chromosome counts which showed it to be a distinct, fertile diploid (Matthews et al. 2002); and (2) comparative genetic studies with its putative parents (H. grosserratus and H. angustifolius), which showed that it does not exhibit a mixture of parental alleles at nuclear loci and does not share chloroplast DNA haplotype with either of its putative parents (Ellis et al. 2006). In contrast, the Kartesz checklists (1994 and 1999) treat this taxon as a hybrid between Helianthus angustifolius and H. grosseserratus, following earlier treatments written when it was known from only the type specimen (NatureServe, 2015).

**Historical Range**

The species is known from Cherokee County, Alabama; Floyd County, Georgia; and McNairy and Madison Counties, Tennessee (USFWS, 2013).

**Current Range**

This species occurs in remnant prairie habitats found in uplands and swales of headwater streams in the Coosa River watershed in Georgia and Alabama and in the East Fork Forked Deer and Tuscumbia Rivers' watersheds in Tennessee (USFWS, 2014).

**Critical Habitat Designated**

Yes; 8/26/2014.

**Legal Description**

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Helianthus verticillatus (Whorled Sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Indiana, Alabama, Georgia and Tennessee (79 FR 50990-51039).

**Critical Habitat Designation**

The critical habitat designation for Helianthus verticillatus includes four CHUs in Cherokee County, Alabama; Floyd County, Georgia; and Madison and McNairy Counties, Tennessee. This species critical habitat encompasses approximately 1,542.3 acres (ac) (624.2 hectares (ha)) (79 FR 50990-51039).

Unit 1: Mud Creek: Unit 1 consists of 210.6 ha (520.4 ac) of privately owned lands in Cherokee County, Alabama, located approximately 11.6 km (7.2 mi) southeast of the city limits of Cedar

Bluff. The unit begins approximately 0.06 km (0.04 mi) north of the junction of CR–164 and CR–29 and extends in a northerly direction to encompass much of the drainage area of an unnamed tributary to Mud Creek and to the northeast to encompass much of the drainage area of a second unnamed tributary to Mud Creek. The easternmost boundary of this unit is adjacent to CR– 101, from approximately 1.0 km (0.6 mi) to 1.4 km (0.9 mi) north of its junction with CR–164. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses; and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 2: Coosa Valley Prairie: Unit 2 consists of 366.9 ha (906.5 ac) of privately owned lands in Floyd County, Georgia, located approximately 4.5 km (2.8 mi) northwest of the city limits of Cave Spring. This unit corresponds to the boundary of The Nature Conservancy's conservation easement on lands formerly owned by The Campbell Group and now owned by Plum Creek, a site commonly referred to as the Coosa Valley Prairie. The northern boundary of this unit follows Jefferson Road for approximately 1.4 km (0.9 mi) in a southeasterly direction, beginning approximately 1.7 km (1.0 mi) east of the Alabama-Georgia State line. From the eastern extent on Jefferson Road, the unit boundary follows an unnamed dirt road south for a distance of approximately 1.5 km (0.9 mi), where the boundary turns to the west and south before turning back to the north and again to the west, reaching the Alabama–Georgia State line. Here, the unit follows the State line in a northwest direction for approximately 0.8 km (0.5 mi) before turning east and following an unnamed dirt road in a northeasterly direction for approximately 2.7 km (1.7 mi) and reuniting with the northern boundary on Jefferson Road. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, depressions, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). Prairie openings and woodlands with low levels of canopy cover (PCE 2) are present throughout much of the unit. While Ellis and McCauley (2009, pp. 1837–1838) found very few viable achenes and low germination rates at this site, whorled sunflower has responded favorably to habitat management efforts by increasing in numbers, and there likely are now a sufficient number of compatible mates for production of viable achenes (PCE 3) at this site. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses, and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 3: Prairie Branch: Unit 3 consists of 6.0 ha (14.9 ac) of privately owned land in McNairy County, Tennessee, and is located approximately 0.6 km (0.5 mi) south of the easternmost city limit of Ramer. This unit is located along Prairie Branch, a tributary to Muddy Creek, beginning approximately 0.42 km (0.26 mi) upstream of the point where it passes under Mt. Vernon Road and extending downstream for approximately 2.0 km (1.2 mi). Within this reach, the critical habitat unit forms a buffer extending 15 m (50 ft) upslope from the tops of the banks on both sides of Prairie Branch. Sandy loam soils (PCE 1) are present throughout the unit, as are small patches of vegetation containing whorled sunflower and other wet prairie species (PCE 2). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing for road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and competition from invasive, nonnative plants.

Unit 4: Pinson: Unit 4 consists of 40.7 ha (100.5 ac) of privately owned land in Madison County, Tennessee, and is located approximately 4.1 km (2.5 mi) northwest of the city limits of Henderson, Tennessee. Beginning approximately 0.7 km southeast of the junction of U.S.–45 and Bear Creek Road, this unit extends approximately 0.08 km (0.05 mi) northeast of U.S.–45, crossing a railroad track, and then turns in a southeasterly direction, paralleling the track for a distance of approximately 0.5 km (0.3 mi). From this corner, the unit boundary turns southwest for a distance of approximately 0.79 km (0.49 mi), and then turns to the northwest for a distance of approximately 0.65 km (0.4 mi). From this corner, the unit boundary turns to the northeast for a distance of approximately 0.63 km (0.39 mi). Silt loam soils (PCE 1) are present throughout the unit, small patches of vegetation containing whorled sunflower and wet prairie species (PCE 2) are present, and a sufficient number of compatible mates are present for the production of a limited number of viable achenes (PCE 3) (Ellis and McCauley 2009, p. 1838). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and excessive shading or competition from native woody species or invasive, nonnative plants. Much of the land within this unit has been converted to agricultural uses, but is included because of the potential for decreasing fragmentation among the subpopulations that are present in this unit by restoring suitable vegetation within previously converted lands.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Helianthus verticillatus critical habitat consists of three components (79 FR 50990-51039):

(i) Silt loam, silty clay loam, or fine sandy loam soils on land forms including broad uplands, depressions, stream terraces, and floodplains within the headwaters of the Coosa River in Alabama and Georgia and the East Fork Forked Deer and Tuscumbia rivers in Tennessee.

(ii) Sites in which forest canopy is absent, or where woody vegetation is present at sufficiently low densities to provide full or partial sunlight to whorled sunflower plants for most of the day, and which support vegetation characteristic of moist prairie communities. Invasive, nonnative plants must be absent or present in sufficiently low numbers to not inhibit growth or reproduction of whorled sunflower.

(iii) Occupied sites in which a sufficient number of compatible mates are present for outcrossing and production of viable achenes to occur.

**Special Management Considerations or Protections**

The features essential to the conservation of whorled sunflower may require special management considerations or protection to reduce the following threats: (1) Soil disturbance due to silvicultural site preparation, timber harvest, or cultivation of row crops; (2) indiscriminate herbicide use or mowing; (3) conversion of remnant prairie habitat to agricultural or industrial forestry uses; and (4) excessive shading or competition from native woody species or invasive, nonnative plants. Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production; (2) ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season; (3) locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible; (4) managing, including prescribed burning, mowing, and bushhogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation; (5) reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat; and (6) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Vegetative (NatureServe, 2015); sexual (inferred from USFWS, 2014)

**Breeding Season**

Adult: August - October (USFWS, 2013)

**Reproduction Narrative**

Adult: The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009) (NatureServe, 2015). This species is self-incompatible (USFWS, 2014). It produces flowers from August into October (Matthews et al. 2002, pp. 17–20; Ellis and McCauley 2008, p. 1837) (USFWS, 2013).

**Habitat Type**

Adult: Terrestrial, wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Wet prairie, calcareous barrens, riparian (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full to partial sunlight (USFWS, 2014)

**Geographic or Habitat Restraints or Barriers**

Adult: Succession (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2013)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: A narrow habitat specialist occurring in remnant wet prairie areas and calcareous barrens, in moist, prairie-like openings in woodlands and along adjacent creeks. Soils are sandy clays which are alkaline, high in organic matter, and seasonally wet. Some associated plant species, including Schizachyrium scoparium, Sorghastrum nutans, Andropogon gerardii, and Panicum virgatum, suggest a strong prairie affinity. Other associates include Carex cherokeensis, Sporobolus heterolepis, Physostegia virginiana, Silphium terebinthinaceum, Pycnanthemum virginianum, Symphyotrichum novae-angliae, Hypericum sphaerocarpum, H. angustifolius, Helenium autumnale, and Marshallia mohrii. Most remaining wet prairies are remnants along rights-of-way where succession is artificially impeded (Call 2009) (NatureServe, 2015). The soil types are silt loams, silty clay loams, and fine sandy loams at the sites where whorled sunflower occurs. These soils share the characteristics of being strongly to extremely acidic and having low to moderate natural fertility and low to medium organic matter content (USDA 1997, pp. 73–76; USDA 1978a, pp. 24–54; USDA 1978b, p. 20; USDA 1978c, p. 44). Full or partial sunlight for most of the day is an essential feature for this species (USFWS, 2014). Initial efforts to estimate population sizes of whorled sunflower relied on counting individual stems (Allison 2002, pp. 3–8; Schotz 2001, pp. 8–10); however, due to the species' clonal growth habit, stem counts overestimate the true number of genetically distinct individuals (genets) (USFWS, 2013).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Species Trends:**

Unknown (NatureServe, 2015)

**Number of Populations:**

26 extant (USFWS, 2025)

**Additional Population-level Information:**

Whorled sunflower, a perennial member of the aster (or sunflower) family, is known from nine natural populations in Alabama, Georgia, Mississippi, Tennessee, and Virginia, of which eight are extant. In addition, there is one established population in Tennessee. Natural populations are threatened by mechanical and chemical vegetation management for industrial forestry, rightofway maintenance, and agriculture; shading and competition resulting from vegetation succession; and limited distribution and small population sizes (USFWS, 2023).

**Population Narrative:**

Whorled sunflower was known from five populations in 2020 and increased to eight extant populations in 2023 (Service 2020, 2023b, respectively). Surveys and chance discoveries have revealed additional populations in Mississippi and Virginia, most of which were found in Mississippi (Kees 2022; Breeden 2024b) so that 26 natural, extant populations are now known across the species' range. Mississippi. These recent discoveries have increased whorled sunflower's known range by six counties in Mississippi (including new discoveries in both counties with previously known populations; Table 1; Figure 1). While recent surveys have revealed substantially more populations in Mississippi (3 populations in 2023 versus 21 now), these populations are generally small, consisting of one to several stems, but can be locally abundant with 100s of stems (Breeden 2024b). These surveys may have also found 20 additional populations in Mississippi, but lack of access to plants prevented confirmation of species identity (Breeden 2024b). Virginia. In Virginia, one new population was recently discovered in Roanoke County; however, this is considered to be a planted population (Townsend 2023, pers. comm.; Virginia Botanical Associates 2025). The provenance of Virginia's previously discovered population has also been questioned and may have also been planted (see Service 2023c for more detail). Both Virginia's previously known population and recently discovered planted population occur on conservation lands—the National Park Service's Blue Ridge Parkway in Franklin County and county owned land Roanoke County, respectively. Additional monitoring and evaluation of Roanoke County's whorled sunflower will be required. Tennessee. Recent discovery surveys in Tennessee did not identify any new populations (Breeden 2024b). Two small populations in Tennessee have been transplanted (Table 1), one on Freed-Hardeman University in Chester County (described in more detail in Service 2020) and another established on Madison County's Pinson Mounds Archaeological Park in 2022 and 2023 (Breeden 2024b). Additional potential reintroduction sites in Tennessee have also been identified. Of Tennessee's two remaining natural populations, one is small (less than 10 stems in 2022) and the other consists of several patches collectively supporting over 200 stems as of 2022 (Tennessee Department of Environment and Conservation 2024). Georgia. Georgia's population, located on private timber lands protected by a conservation easement, is in apparent decline possibly due to the lack of prescribed fire in recent years (Breeden 2024a, pers. comm.; Brown 2024, pers. comm.). The Georgia population was previously robust and one of the largest known populations (Service 2020, 2023c). Alabama. Alabama's population is split among two small sites in Cherokee County (Service 2023c; Thompson and Kirby 2023). A small test planting of 10 rhizomes in DeKalb County, Alabama, was completed during 2021 (Thompson and Kirby 2023), but this site is not yet counted toward recovery given its preliminary nature. (USFWS, 2025)

### *Threats and Stressors*

**Stressor:** Habitat destruction and modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threats to whorled sunflower from habitat destruction and modification are occurring throughout the entire range of the species. These threats include mechanical or chemical vegetation management associated with industrial forestry practices, maintenance of transportation and utility rights-of-way, agricultural practices, and shading and competition. While a conservation easement and suitable habitat management alleviate threats from industrial forestry that otherwise would adversely affect the Georgia population, one of the Alabama whorled sunflower subpopulations currently is threatened by industrial forestry

practices. The population-level impacts from these activities are expected to continue into the future (USFWS, 2013).

**Stressor:** Small, isolated populations (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The whorled sunflower is vulnerable to localized extinction because of its extremely restricted distribution and small population sizes at most known locations, which reduces the resilience of these populations to recover from acute demographic effects of threats to its habitat. the highly fragmented distribution of populations within Tennessee, combined with their disjunct location with respect to those in Georgia and Alabama, presumably precludes gene flow among them and leaves little chance of natural recolonization of these populations in the event of localized extinctions. Small population size could be affecting reproductive fitness of the whorled sunflower. The findings of Ellis and McCauley (2008, entire) suggest that the Madison County, Tennessee, population is reproductively less fit than the Alabama population. Ellis and McCauley (2008, p. 1840) offered two possible explanations for reduced reproductive fitness of the Tennessee population, including limited mate availability due to limited diversity of self-incompatibility alleles, or more extensive inbreeding. Both could be contributing to reduced seed production and viability rates (USFWS, 2013).

**Stressor:** Industrial Forestry Practices (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Industrial forestry practices have altered much suitable whorled sunflower habitat in Georgia and Alabama and currently threaten one known subpopulation in Alabama. While surveying potential habitat for additional populations, Jim Allison (Botanist, GDNR, pers. comm., March 9, 1999) observed that much of this species' prairie habitat in Georgia had been converted to pine plantations. Nearly all the Georgia subpopulations and one of the Alabama subpopulations of whorled sunflower are located on lands that are currently owned by Weyerhaeuser. The Georgia subpopulations on Weyerhaeuser Company lands are protected from habitat destruction or degradation by their inclusion in the conservation easement area at the Coosa Valley Prairie, which was donated to TNC by a previous landowner. On lands outside of the conservation easement area at the Coosa Valley Prairie, site preparation for planting pine seedlings has included subsoil plowing sites to improve drainage and conditions for tree root development. Mechanical and chemical methods to control competing vegetation have also been employed for site preparation. These site preparation activities may continue under Weyerhaeuser's ownership, depending on site conditions and needs, but buffers and alterations to specific site preparation practices are employed to limit impacts to rare species (Muckenfuss, pers. comm., September 14, 2017), such as whorled sunflower. Without adequate precautions, these practices could cause direct mortality of whorled sunflower plants at one of the Alabama subpopulations and contribute to habitat degradation due to shading and competition (see "Shading and Competition", below) from planted pines. During timber harvests, either to thin (i.e., reduce density of pine trees to improve growth conditions for remaining trees) or to clear-cut the stand, whorled sunflower plants at this subpopulation could be subjected to indirect adverse effects from soil disturbance or to direct mortality due to movement of harvesting equipment (USFWS, 2023)

**Stressor:** Right-of-Way Maintenance (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Incompatible maintenance activities in utility and transportation ROWs have adversely affected whorled sunflower in Alabama, Mississippi, and Tennessee, and could affect one subpopulation in Georgia. At one of the Alabama subpopulations, whorled sunflower occurs in a narrow strip of vegetation between a roadside and adjacent pine forest, where it is vulnerable to mortality or reduced vigor and reproductive output due to indiscriminate use of herbicides or mowing for ROW maintenance. Poorly timed mowing of this ROW prevented flowering and seed production in some plants at this site in 2008; however, the Alabama Department of Conservation and Natural Resources (ADCNR), Alabama Department of Transportation, and Cherokee County Highway Department cooperated in placing signs at the site to mark the presence of whorled sunflower and attempt to prevent this in the future (Dr. Wayne Barger, Botanist, ADCNR, pers. comm., February 10, 2009); although, periodic replacement might be needed due to vandalism or removal of the signs (Barger, pers. comm., March 6, 2012). In Mississippi, whorled sunflower plants discovered growing in a road ROW in August 2017 were apparently been sprayed with herbicide during the intervening weeks between the initial discovery and a follow-up visit later in the month, which visibly stressed the plants, but did not apparently kill them (Brandon, pers. comms., August 12, 2017, and August 17, 2017). These plants remained extant into 2018 (Brandon, pers. comm., August 6, 2018); however, follow-up visits in 2020 could not relocate plants within the ROW (Breeden, pers. comm., September 14, 2020). Both of Mississippi's remaining two populations also occur in road ROWs and are vulnerable to similar indiscriminate herbicide application. Similarly, plants extending onto a roadside within a power line ROW at the Madison County, Tennessee population were sprayed with herbicide during roadside and power line maintenance in 2004, causing significant mortality (David Lincicome, Rare Species Protection Program Administrator, TDNA, pers. comm., September 22, 2006; Andrea Bishop, Botanist, TDNA, pers. comm., February 21, 2008). Likewise, plants extending into the railroad ROW at the McNairy County, Tennessee, population are vulnerable to adverse effects from potential indiscriminate herbicide application used for railroad ROW maintenance, but installation of appropriate signage may alleviate this threat. A small cluster of plants in one of Georgia's subpopulations is located on the bank of a road adjacent to the Coosa Valley Prairie easement area and is not protected. These examples indicate that incompatible vegetation management (such as indiscriminate herbicide application or poorly timed mowing) along transportation and utility ROWs could adversely affect whorled sunflower populations in Alabama, Mississippi, and Tennessee, and a small subpopulation in Georgia. Regular coordination with parties responsible for maintenance of these ROWs locations will be necessary to avoid future adverse effects to local whorled sunflower populations from indiscriminate mowing or herbicide application (USFWS, 2023).

**Stressor:** Agricultural Practices and Land Conversion (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Whorled sunflower has not been rediscovered at the type locality in Tennessee despite intensive surveys of that area (Nordman 1998, pp. 1–2, Nordman 1999, p. 2). This record is from an 1892 collection and locality information is vague (Matthews et al. 2002, p. 13), so it is

not possible to determine why this population was lost. In Tennessee, much of this species' suitable habitat has presumably been converted to agricultural use, as substantial proportions of the counties in the state where the species has been found have been in row crop production since 1850 (Table 3) (Waisanen and Bliss 2002, p. 13; geographic information system [GIS] data available at http://landcover.usgs.gov/cropland, accessed January 9, 2013). Because this species was not seen following the initial 1892 collection until it was rediscovered in 1994, and was not seen again in Tennessee until 1998, it is impossible to be certain about the historical distribution and abundance of its habitat. However, the data presented in Table 3 indicate that land conversion to agricultural uses has a long and sustained history in the Tennessee counties where whorled sunflower has been found and has likely contributed to loss of the species' habitat and populations (USFWS, 2023).

**Stressor:** Shading and Competition (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Absent natural or human-caused disturbance, habitats where whorled sunflower occurs are threatened by succession of vegetation to a shrub-dominated or forested condition. The largest concentration of plants at the Madison County, Tennessee, population is in a successional old field approximately 1 ha (2.5 ac) in size, which has become almost entirely wooded (Lincicome, pers. comm., November 30, 2017), degrading the largest patch of contiguous habitat where most of this population occurs. Woody species present at this site include Acer negundo (box elder), Liquidambar styraciflua (sweetgum), and Salix nigra (black willow) (TDNA 2006, p. 5), all of which can rapidly invade moist old-field habitats if left unmanaged. No conservation agreements or management plans are in place to ensure that this site receives periodic disturbance to maintain open conditions needed for the growth and sexual reproduction of whorled sunflower. Invasive plants, including, Lonicera japonica (Japanese honeysuckle), Microstegium vimineum (Nepalese browntop, Japanese stiltgrass), and Rosa multiflora (multiflora rose), have been noted at both natural populations in Tennessee (Caitlin Elam, Botanist, Division of Natural Areas, Tennessee Department of Environment and Conservation, pers. comm., October 14, 2019). Likewise, the invasive Ligustrum sinense (Chinese privet) is a persistent problem for Georgia's population (USFWS, 2023)

**Stressor:** Climate Change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since 1970, the average annual temperature across the Southeast has increased by about 2°F, with the greatest increases occurring during winter months. The geographic extent of areas in the Southeast region affected by moderate to severe spring and summer drought has increased over the past three decades by 12 and 14 percent, respectively (Karl et al. 2009, p. 111). These trends are expected to increase. Rates of warming are predicted to more than double in comparison to what the Southeast has experienced since 1975, with the greatest increases projected for summer months. Depending on the emissions scenario used for modeling change, average temperatures are predicted to increase by 4.5°F to 9°F by the 2080s (Karl et al. 2009, p. 111). While there is considerable variability in rainfall predictions throughout the region, increases in evaporation of moisture from soils and loss of water by plants in response to warmer temperatures are expected to contribute to increased frequency, intensity, and duration of

drought events (USFWS, 2023)

***Recovery***

**Reclassification Criteria:**
CRITERION 1. At least 20 geographically distinct populations—separated by at least 1 mile (1.6 kilometer)—of at least moderate size (at least 100 individuals) are distributed across the species' range, with each of the 4 known ecoregions (Loess Plains, Northern Hilly Gulf Coastal Plain, Southern Crystalline Ridges and Mountains, and Southern Shale Valleys)1 supporting at least 3 such populations, including 1 population within each of the 4 designated critical habitat units. (Addresses Factors A and E.) (USFWS 2023).

CRITERION 2. At least 3 large populations (at least 500 individuals), protected by long-term conservation mechanisms, occur in each of the 4 known ecoregions, for a total of 12 protected populations, and are managed to promote open-canopied habitat, native plant community integrity, and support resilient populations2 of whorled sunflower. (Addresses Factors A, D, and E.) (USFWS, 2023).

CRITERION 3. Monitoring demonstrates that these populations (described in Criteria 1 and 2) are viable, as evidenced by natural recruitment and having stable to increasing populations for at least 10 years (approximately 10 generations). (Addresses Factor E.) (USFWS, 2023).

Recovery Priority Number: 5

**Delisting Criteria:**
Whorled sunflower may be considered for delisting when the above criteria are met and when:
CRITERION 4. At least 20 additional geographically distinct populations of at least moderate size occur within the species' known range for a total of at least 40 extant populations. (Addresses Factors A and E.) (USFWS, 2023).

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production (USFWS, 2014).
- Ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season (USFWS, 2014).
- Locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible (USFWS, 2014).
- Managing, including prescribed burning, mowing, and bush hogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation (USFWS, 2014).
- Reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat (USFWS, 2014).
- Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat (USFWS, 2014).

- 1. Work with rights-of-way stakeholders to develop and implement management agreements (USFWS, 2023).
- 2. Work with federal and state agencies, non-governmental conservation organizations, and private landowners to obtain protection for populations on privately owned lands (USFWS, 2023).
- 3. Work with partners and stakeholders to develop and implement management plans for all populations (USFWS, 2023).
- 4. Work with partners and stakeholders to develop and implement a monitoring strategy for all populations (USFWS, 2023).
- 5. Increase the representation and genetic diversity of ex situ (offsite) safeguarding collections of whorled sunflower (USFWS, 2023).
- 6. Facilitate and support surveys to identify new whorled sunflower populations (USFWS, 2023).
- 7. Population augmentation and establishment (USFWS, 2023).
- 8. Conduct research that enhances knowledge of whorled sunflower biology and ecology to facilitate the development of scientifically sound management plans, population viability models, and species/habitat distribution models (USFWS, 2023).
- 9. Coordinate with federal, state, county, and local agencies, and other stakeholders to promote whorled sunflower recovery and identify innovative ways to increase public awareness of the need to protect this species and its habitats (USFWS, 2023).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Finalize the recovery plan. 2. Continue and expand work with federal and state conservation agencies, nongovernmental organizations, right-of-way owners and managers, and private individuals and organizations to protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. 3. Safeguard representative genetic material from all known populations. 4. Search for new populations. 5. Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. 6. Conduct studies into the species' life history, biology, and ecology to improve management of the species and its habitat. 7. Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity and long-term viability. 8. Investigate metapopulation structure and dynamics of the species. (USFWS, 2020)
- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery criteria and actions are presented in the species' Recovery Plan (Service 2023b) and Recovery Implementation Strategy (Service 2023a). During this status review, new and/or targeted potential recovery activities were identified. These actions are recommended to support and promote recovery of whorled sunflower. Recommendation numbers are for convenient reference only and do not imply prioritization of any activity over others. Recovery Activities 1. Expand searches for additional locations throughout the species' range to identify additional populations. 2. Continue pursuing population establishment and augmentation on protected lands. 3. Continue to expand ex situ (off-site) conservation activities, such as seed banking and growing plants in cultivation, to encompass more populations and increase genetic representation in safeguarding collections. 4. Work with landowners and other interested parties to improve habitat management and pursue protection of populations. Monitoring and Research Activities 1. Complete genetic and morphological study to determine if Mississippi's populations are taxonomically distinct from other whorled sunflower populations. 2. Create species distribution model to guide future population searches and identify potentially

suitable areas for potential population establishment. 3. Study pollinator community associated with the whorled sunflower to inform population delineation, understanding of population connectivity, and habitat management needs. 4. Expand genetics studies to better understand population delineation, connectivity, and dynamics. (USFWS, 2025)

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# SPECIES ACCOUNT: *Hesperolinon congestum* (Marin dwarf-flax)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 02/03/1995; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An annual herb with linear leaves and slender stems, generally 5-15 cm tall but occasionally reaching 40 cm. Flowers (May-July) are white to rose-colored with purple anthers; they are borne in congested clusters. Anthers are purple at time of pollen release. 3 carpels and styles (NatureServe, 2015).

**Taxonomy**

A member of the flax family (Linaceae) (USFWS, 2011). J. K. Small (1907) established Hesperolinon as a distinct genus in 1907 (USFWS, 1998).

**Historical Range**

Its historical range has not been established, but likely included all occurrences at the time of listing, as well as extirpated occurrences on former serpentine areas in San Francisco and San Mateo Counties that are now urban development (USFWS, 2011).

**Current Range**

It is known to occur in serpentine soils in San Mateo, San Francisco, and Marin Counties, typically in association with bunchgrasses, chaparral, or other dry grasslands (USFWS, 2023).

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 1998)

**Lifespan**

Adult: 1 year (NatureServe, 2015)

**Breeding Season**

Adult: May - July (USFWS, 2011)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 1998)

**Reproduction Narrative**

Adult: This species is an annual (NatureServe, 2015). The species generally flowers from early May through June or July, and is sensitive to the amount and timing of rainfall (USFWS, 2011). The species is pollinated by native insects including bee flies and pollen beetles (Robison and

Morey 1992a) (USFWS, 1998).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grasslands and chaparral (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 100 - 1,200 ft. elevation (USFWS, 1998)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: High (inferred from USFWS, 2011)

**Habitat Narrative**

Adult: Inhabits grasslands and chaparral on serpentine soils. The environmental specificity is very narrow; it is a narrow serpentine endemic only known from serpentine sites in parts of the S. F. Bay area (NatureServe, 2015). Serpentine soils are formed from weathered volcanic rock, with a low calcium-magnesium ratio, lack of soil nitrogen, potassium, or phosphorus, and elevated heavy metals (mineral toxicity). It is believed that Hesperolinon congestum's tolerance for this soil chemistry allows it to grow where most other plant species cannot (USFWS, 2011). Known populations occur between approximately 30 and 370 meters (100 to 1,200 feet) (California Natural Diversity Data Base 1996) (USFWS, 1998).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

**Species Trends:**

10 - 30% decline (NatureServe, 2015)

**Number of Populations:**

23 extant (USFWS, 2023)

**Population Size:**

10,000 - 1,000,000 individuals (NatureServe, 2015)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Additional Population-level Information:**

The final listing rule did not provide abundance estimates for any of the known Marin dwarf-flax occurrences but did note they can fluctuate in size from hundreds to thousands of plants (Robison and Morey 1992, p. 7; Service 1995, p. 6675). In the previous 5-year review we stated abundance estimates for most locations had been occasional and often qualitative, and when recorded would vary greatly among occurrences and between years. Similar to the previous review, we do not have abundance estimates for most locations; however, for the locations we do have data for, abundance varied greatly (Chassé et al. 2019; Williams and O'Herron 2019, p. 68; Diversity Database 2020) (see Appendix, Table B). The widespread variability in Marin dwarfflax abundance is not surprising as numbers are known to be greatly affected by rainfall, with more individuals in years with abundant spring rains (Service 2011, p. 6). Because of this variability, it is difficult to determine population dynamics and trends of each occurrence without multiple years of tracking, and currently only a few occurrences of Marin dwarf-flax are being regularly monitored (see Appendix, Table B). Moreover, for many occurrences the only available information is what was submitted to the Diversity Database, which often includes little quantitative information on the species, making it difficult to analyze abundance trends (USFWS, 2023).

**Population Narrative:**

Vulnerable due to its fluctuating population numbers based on rainfall and due to its frail, annual habit. The population numbers of this annual fluctuate with rainfall. There may be a few hundred at a site one year and 10's of thousands the next. One recently reported site at Lucasfilms property had 200,000 plants one year. The total estimated population size is 10,000 - 1,000,000. The long term trend for this plant is one of severe decline due to urbanization of its habitat; decline of 50-70%. This species has experienced a short term decline of 10 - 30% due to urbanization. The population numbers of this annual fluctuate with rainfall. There may be a few hundred at a site one year and 10's of thousands the next. One recently reported site at Lucasfilms property had 200,000 plants one year (NatureServe, 2015). At the present time, there are 23 extant occurrences of the species (USFWS, 2011). The 1995 final listing rule stated there were fourteen known occurrences: six from Marin County, one from San Francisco County, and seven from San Mateo County (Service 1995, p. 6679). The previous 5-year review reported 23 extant, 2 unreliable, and 5 extirpated occurrences of the Marin dwarf-flax. Of these extant occurrences, 11 were from Marin County, 2 from San Francisco County, and 10 from San Mateo County (Service 2011, pp. 3–6). Currently, there are 23 extant occurrences, 1 unreliable occurrence, 2 possibly extirpated occurrences, and 1 extirpated occurrence reported in the Diversity Database (2020) (see Appendix, Table A). Although CNDDB labels 23 occurrences as “Presumed Extant,” most of these occurrences have not been seen and/or surveyed in several years and therefore are labeled as “Unknown” in the Appendix, Table A. Since the previous 5-year review, two new occurrences have been reported to the Diversity Database (occurrence #34 and #35) and some of the previous occurrences have been combined (#30 included in #3, #2 included in #1, #15 included in #14, and #10 included in #9) (see Appendix, Table A). New occurrence #34 expands the previously known range further north. New occurrence #35 is within the range known at the time of listing. Of the 23 extant occurrences, 13 are from Marin County, 2 are from San Francisco County, and 8 are from San Mateo County (USFWS, 2023)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threat of habitat destruction continues in several forms, and varies both regionally and with specific location. Recent information concerning the Alta Robles development indicates there would be some direct impacts to Hesperolinon congestum, as well as likely indirect impacts due to construction at distances of 25-to-125 feet from the species and/or potential habitat (MCL 2011; MIJ 2010; Town of Tiburon 2010). These distances are far less than the 500-foot buffer recommended in our Recovery Plan for protection of this species (FWS 1998). Not only do such developments result in direct losses of the species and its habitat where the development takes place, but could result in numerous indirect effects on adjacent areas due to runoff, landslides, foot traffic, dogs, and non-native plant competition. These indirect effects may occur on both private and public lands, particularly in areas which lack permanent protections. Such indirect effects are likely to be ongoing to some extent at all of the Tiburon populations due to nearby developments. Based on information provided by the SFPUC and review of Service files, several planned actions may affect the species (E. Natesan, SFPUC, pers. comm. 2011). One such activity is the Crystal Springs/San Andreas Transmission Upgrade project, whose modest effect on Hesperolinon congestum will be mitigated through conservation and enhancement measures addressed in formal consultation (FWS 2010; Table 2). There is also a planned dam improvement project for Crystal Springs Reservoir which could affect Hesperolinon congestum or presently unoccupied serpentine area which is potential habitat over a more widespread area by allowing a higher maximum water level than at the present time. More development, even without actual direct impacts, may indirectly impact Hesperolinon congestum through occasional foot traffic, or local atmospheric pollutants. These effects have not yet been evaluated (USFWS, 2011).

**Stressor:** Ground disturbance (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Ground disturbance in serpentine areas from unmonitored casual recreational activities continues to be a threat to the species. Hiking and biking activity has been mentioned as a potential or actual threat for at least fourteen occurrences. At Middle Ridge (#8), unleashed dogs are mentioned to be the main cause of ground disturbance (often by professional dog-walkers), and hiking and bike traffic were also noted (Bittman, in litt. 2009a, 2009b; Buxton, in litt. 2010, pers. comm. 2011; LSA 2010) (USFWS, 2011).

**Stressor:** Succession (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Atmospheric nitrogen deposition derived from combustion sources like motor vehicles and industry in urban areas may be enriching otherwise low-nutrient serpentine soils. This may be allowing other native and nonnative plant species, such as rye grass (Lolium spp.) or wild oats (Avena spp.), to invade some serpentine areas and compete with serpentine specialist species such as Hesperolinon congestum. Over time, thatch and soil buildup from the invading plants can further enrich serpentine soils. Based on the estimated critical load of 4.5-5.0 kg-N/ha/year for

serpentine natives such as Hesperolinon congestum, nitrogen is a potential threat to this species throughout its range with the exception of more rural parts of Marin County (Weiss, in litt. 2011; Fenn et al. 2010). Studies in the south bay suggest that non-natives have had an effect on other native serpentine plants at Edgewood Park (Weiss 1999), although it has not yet been demonstrated for Hesperolinon congestum in particular (USFWS, 2011).

**Stressor:** Maintenance activities (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Maintenance as a potential threat was noted at a number of locations and in various forms. Maintenance activities identified since listing included access roads, pipeline maintenance, highway maintenance, disking, herbicide spraying, and "other" maintenance. Maintenance can have a direct effect by disturbing the plants and its habitat, or indirect effects by altering the hydrology/runoff or land stability of a site (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Preliminary results indicate an increase in average maximum summer air temperature at Golden Gate National Recreation area, located near the Presidio (near occurrences #16 and 20), and a statewide reduction in fog frequency (Madej et al. 2010; Johnstone and Dawson 2010). Hesperolinon congestum abundance and flowering period is believed to be affected generally by year-to-year variations in rainfall, so it may be sensitive to climate change. However, there is inadequate information to make accurate predictions regarding its effect on this species at this time (USFWS, 2011).

**Stressor:** Stochastic events (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Low plant number remains a threat to the smaller population size occurrences of Hesperolinon congestum. The small areas of these occurrences render them susceptible to extirpation as a result of localized stochastic events or disturbances from threats already discussed (USFWS, 2011).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8C

**Delisting Criteria:**
1. Secure and protect specified recovery areas from incompatible uses: Occupied habitat or 21 populations representing the range of the species along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer (USFWS, 2011).

2. Management plan approved and implemented for recovery areas, including survival of the species as an objective; for all populations and any occupied or unoccupied habitat identified as essential to survival (USFWS, 2011).

3. Population monitoring in specified recovery areas shows stable or increasing plant numbers for a period of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2011).

**Recovery Actions:**
- Habitat protection (USFWS, 1998).
- Habitat management and restoration, including removal of invasive non-native species (USFWS, 1998).
- Surveying and monitoring (USFWS, 1998).
- Ex-situ conservation measures such as artificial rearing and seed banking (USFWS, 1998).
- Research (USFWS, 1998).
- Public participation, outreach, and education (USFWS, 1998).
- Secure and protect all occurrences and potential (unoccupied) serpentine grassland habitat necessary for recovery of Hesperolinon congestum on SFPUC lands in the Crystal Springs group (as previously mentioned, our Formal Consultation applies only to a portion of the occurrences, see FWS 2011). The conservation easements, together with a comprehensive and complete management plan, should be sought to permanently protect all occurrences and potential habitat from future habitat loss due to changes in land use. The management plan should include provisions for monitoring, actions as necessary to quantify and address threats of non-native species encroachment, and means to resolve foreseeable potential conflicts created by human use or operations and maintenance activities (USFWS, 2011).
- Secure and protect to the maximum extent practicable, all occurrences and potential (unoccupied) serpentine grassland habitat necessary for recovery of Hesperolinon congestum at the St. Hilary's Church (#6) and Middle Ridge (#8) locations. In addition to recreational and non-native plant threats, portions of these sites are believed to be imminently threatened by potential conversion to housing developments. Avoidance of any loss is the preferred strategy. Permanent conservation easements should be sought to preclude future loss. One venue for Service participation would be during consultations pursuant to issuance of a permit from the Corps under CWA Section 404. Additionally, there need to be assurances that management, including regular monitoring and corrective action, will be timely implemented as needed to address other primary threats of non-native vegetation and human passive use. Reported adverse human impacts from recreational uses (primarily dog-walking; other uses mentioned include hiking, biking, photography, horse-back riding, photography) to this species or its habitat should be investigated, monitored, and prevented by necessary means, including restricted use/entry where other means have proven ineffective (USFWS, 2011).
- Surveys should be conducted at least once (preferably more often) in this next five years at all known locations of Hesperolinon congestum. In order of priority, surveys should be done for the 10 sites for which this review found no observational information at all in the last five years (#17, 5, 1, 30, 3, 21, 22, 31, 23, and 28), the non-CNDDB site (a), and all other sites. A survey protocol should be developed, which will ideally allow detection of the peak flowering period, a reasonable estimate of population area and size, photodocumentation (of entire area, and closeups of plant forma), establishment of reproducible photo points,

and a rapid assessment of the extent of visible threat factors of human-caused ground disturbance, and non-native/native species invasion (USFWS, 2011).
- Assess the effectiveness of one or more weed control measures on Hesperolinon congestum. This may involve comparing weed densities in areas (occurrence area and adjacent buffer) which are controlled for weeds versus those which are not, or evaluating a chronosequence before, during, and after weed control measures; or comparing different measures. For example, where grazing is used, a study might seek to establish empirical relationships between the control measure (e.g., grazing or grazer density) and weed densities, and the response by Hesperolinon congestum (or lack thereof) (USFWS, 2011).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Marin dwarf-flax. Recommendations #2–5 were discussed in the previous 5-year review (Service 2011, pp. 19–20) and remain valid. 1. Work with partners to develop a standardized methodology to delineate Marin dwarf-flax populations to allow the Service and partners to accurately assess population trends. 2. Secure and protect all occurrences and potential habitat (i.e., unoccupied serpentine grasslands) necessary for recovery of Marin dwarf-flax on SFPUC lands in the Crystal Springs group. Conservation easements, together with a comprehensive and complete management plan, should be sought to permanently protect all occurrences and potential habitat from future habitat loss due to changes in land use. The management plan should include provisions for monitoring, actions as necessary to quantify and address threats of non-native species encroachment and means to resolve foreseeable potential conflicts created by human use or operations and maintenance activities. 3. Secure and protect to the maximum extent practicable, all occurrences and potential habitat (i.e., unoccupied serpentine grasslands) necessary for recovery of Marin dwarfflax at the St. Hilary's Church (Diversity Database #6) and Middle Ridge (Diversity Database #8) occurrences. In addition to recreation and non-native plant encroachment, portions of these sites are threatened by potential conversion to housing developments. Avoidance of any loss is the preferred strategy and permanent conservation easements should be sought to preclude future loss. Additionally, there need to be assurances that management, including regular monitoring, will be implemented as needed to address other primary threats of non-native vegetation and recreational use. Reported adverse human impacts from recreational uses (primarily dog-walking; other uses mentioned include hiking, biking, photography, horse-back riding, photography) to this species or its habitat should be investigated, monitored, and prevented by necessary means, including restricted use/entry where other means have proven ineffective. 4. Conduct surveys at least once (preferably more often) over the next five years at all known locations of Marin dwarf-flax. Develop a survey protocol, which will ideally allow detection of the peak flowering period, a reasonable estimate of occupied area and size, photo documentation (of entire area, and closeups of plant forma), establishment of reproduceable photo points, and a rapid assessment of the extent of visible threat factors of human-caused ground disturbance, and non-native/native species encroachment. 5. Assess the effectiveness of one or more weed control measures on promoting Marin dwarf-flax growth. This may involve comparing weed densities in areas (occurrence area and adjacent buffer) which are controlled for weeds versus those which are not, evaluating areas before, during, and after weed control measures, or comparing different measures. For example, where grazing is used, a study might seek to establish empirical relationships between the control measure (e.g., grazing or grazer density) and weed densities, and the response by Marin dwarf-flax (or lack thereof). 6. There are a variety of other key research needs for the recovery of this species mentioned in our recovery plan that should also be conducted, including: (1) studies on the effects of vegetation management practices (grazing, burning, herbicide), fertilizer, and runoff; (2) demographic studies such as soil seed bank, and other reproductive features (mating system, pollination); and (3) surveys of potential habitat to identify new occurrences. Surveys of potential habitat could also be useful to identify candidate unoccupied serpentine areas for enhancement (i.e., usually tree/scrub removal) and outplanting. Population genetic studies could be done to determine the extent of differentiation throughout the species' range and how this compares to phenotypic variation noted between occurrences (Smith, in litt. 2011a in Service 2011, p. 7, cover photo). These studies may be useful to select outplanting material should unoccupied restoration sites be identified. If such studies are warranted, collection and preservation of material for genetic study could be done at the same time of surveys (recommendation #2, above). As mentioned in the Recovery criteria section above, there is also a need to refine the recovery criteria in order to objectively assess progress towards recovery. These actions and others listed in our recovery plan may be essential for recovery of the species but may require additional information and analysis to prioritize and implement (USFWS, 2023).

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# SPECIES ACCOUNT: *Hibiscus dasycalyx* (Neches River rose-mallow)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/11/2013; Southwest Region (R2)

**Physical Description**

The rose-mallow is a nonwoody perennial in the Malvaceae (mallow) family that grows 1.9-7.5 feet (ft.) (0.6-2.3 meters (m)) tall. Leaves are alternate, simple, generally t-shaped, and deeply three-lobed with petioles 1.1-1.8 inches (in) (3-5 centimeters (cm)) long. The species generally produces a single creamy white (rarely pink) flower at the base of the leaf stalk along the uppermost branches or stems. Plants are single to multi-stemmed. Each branch or stem can have numerous leaves, with the total number of flowers per plant numbering in the hundreds. Flowering is rain dependent, spanning a few weeks in June and July. Seeds are set in August (T. Philipps, pers. comm. 2016a). Large, numerous stamens are monadelphous, forming a tube that is united with the base of the petals. Potential pollinators may include, but are not limited to: the American bumble bee (Bombus pensylvanicus), Hibiscus bee (Ptilothrix bombiformis), moths, and the scentless plant bug (Niesthrea louisianica) (Klips 1995, Warnock 1995, Warriner 2011). (USFWS, 2018)

**Taxonomy**

In the Malvaceae (mallow) family (USFWS, 2013)

**Historical Range**

The natural range is within Trinity, Houston, Harrison, and Cherokee Counties, Texas (USFWS, 2013a)

**Current Range**

Known from Trinity, Houston, Harrison, Cherokee, and Nacogdoches Counties in east Texas, in the Neches, Sabine, and Angelina River basins and the Mud and Tantabogue Creek basins (USFWS, 2013a).

**Critical Habitat Designated**

Yes; 10/11/2013.

**Legal Description**

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for Hibiscus dasycalyx (Neches River rose-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas (78 FR 56072-56120).

**Critical Habitat Designation**

The critical habitat designation for Hibiscus dasycalyx includes eleven CHUs in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas. This species critical habitat encompasses approximately 166.5 acres (ac) (67 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule (USFWS, 2013).

Unit 1: SH 94 ROW: Unit 1 consists of 3.4 ac (1.4 ha) on both the 94 ROW and on private land in Trinity County.

Unit 2: Harrison County: Unit 2 is found at a location between 0.2–0.4 mi (0.3–0.6 km) north of Farm to Market Road 2625 in Harrison County.

Unit 3: Lovelady: Unit 3 in Houston County, found northwest of Farm to Market 230, extends 0.3 mi (0.5 km) north and contains 6.3 ac (2.5 ha) of private land.

Unit 4: SH 204 ROW: Unit 4 in Cherokee County contains 8.7 ac (3.5 ha) of occupied habitat along SH 204 ROW and within the Mud Creek basin.

Unit 5: Davy Crockett NF, Compartment 55: Unit 5 is the only unit that contains a natural population of the Neches River rose-mallow on Federal lands within the Davy Crockett NF.

Unit 6: Davy Crockett NF, Compartment 11: Unit 6 includes 7.3 ac (3.0 ha) of occupied habitat on Compartment 11 on Federal land in the Davy Crockett NF within Houston County.

Unit 7: Davy Crockett NF, Compartment 20: Unit 7 includes 3.4 ac (1.4 ha) of Federal land in Compartment 20 of the Davy Crockett NF, Houston County.

Unit 8: Davy Crockett NF, Compartment 16: Unit 8 encompasses 32.8 ac (13.3 ha) of occupied Federal habitat in the Davy Crocket NF, Houston County.

Unit 9: Champion: The Champion site, Trinity County, is located on private land approximately 0.7 mi (1.1 km) south-southeast of the Houston County line, about 0.8 mi (1.2 km) north of the confluence of White Rock Creek and Cedar Creek (TXNDD 2012a, p. 55).

Unit 10: Mill Creek Gardens: Unit 10 is an introduced site at Mill Creek Gardens, Nacogdoches County. Stephen F. Austin State University Mass Arboretum purchased the land and created the gardens in 1995 as part of a conservation agreement.

Unit 11: Camp Olympia: Unit 11 is located on private property in Trinity County. The unit contains 0.2 ac (0.1 ha) of palustrine wetland habitat north of Lake Livingston.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Hibiscus dasycalyx critical habitat consists of two components (78 FR 56072-56120):

(i) Hydric alluvial soils and the potential for flowing water when found in depressional sloughs, oxbows, terraces, side channels, or sand bars; and

(ii) Native woody or associated herbaceous vegetation, largely with an open canopy providing partial to full sun exposure with few to no nonnative species.

**Special Management Considerations or Protections**

Threats to those features that define the primary constituent elements for the Neches River rose-mallow include: (1) Alteration of naturalized flow regimes through projects that require channelization; (2) water diversions or hydrologic change to streams and rivers; (3) encroachment from native woody riparian species and nonnative species; (4) detrimental roadside management practices including inappropriate frequency and timing of mowing during the species' blooming period; (5) herbivory and, (6) trampling from hog and cattle; and (7) drought. Special management considerations or protection are required within critical habitat areas to address these threats. Special management activities that could ameliorate these threats include, but are not limited to: • Construction of cattle exclusion fencing to remedy herbivory at Lovelady to maintain plant survival and suitable habitat; • Restoration of the cattle stock pond back to a natural flatwoods pond at Lovelady to restore the sites hydrology; • Coordination with TXDOT to establish and continue effective management along ROWs for control of native woody species and nonnatives (including, but not limited to mowing, brush-hogging, or other hand-clearing techniques) and completion of these techniques only during the appropriate life stages of the Neches River rose-mallow to maintain open habitat; • Coordination with the Angelina and Neches River Authority and consultation with the U.S. Army Corps of Engineers on the proposed construction of Lake Columbia Reservoir in Cherokee County to maintain hydrology at the downstream Neches River rose-mallow site; • Consultation between the Service and the U.S. Army Corps of Engineers for any filling or draining of Federal jurisdictional wetlands to ensure maintenance of hydrology; and • Clearing or burning on the Davy Crockett NF for control of Chinese tallow and to maintain an adequate level of openness in habitat. (USFWS, 2013)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect (USFWS, 2013a)

**Lifespan**

Adult: Unknown (USFWS, 2013a)

**Breeding Season**

Adult: Flowering occurs between June and August, sometimes into late October (USFWS, 2013a)

**Key Resources Needed for Breeding**

Adult: Insects for pollination (USFWS, 2013a)

**Reproduction Narrative**

Adult: This perennial species dies back to the ground every year and resprouts from the base; however, the plant still maintains aboveground stems. Longevity of the species is unknown, but it may be long- lived. Cross-pollination occurs within populations, and the species has high reproductive potential (fecundity). Flowering occurs between June and August, sometimes into late October; the blooming period may only last 1 day. The species produced an average of 50 fruits per plant, but seed viability and survivorship are not known. Potential pollinators of the Neches River rose-mallow may include, but are not limited to, the common bumblebee (Bombus pensylvanicus), Hibiscus bee (Ptilothrix bombiformis), moths, and the scentless plant bug

Niesthrea louisianica (USFWS, 2013a).

**Habitat Type**

Adult: Wetlands (USFWS, 2013a)

**Habitat Vegetation or Surface Water Classification**

Adult: Seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands (USFWS, 2013a)

**Environmental Specificity**

Adult: Narrow. Specialist or community with key requirements common (NatureServe, 2015)

**Habitat Narrative**

Adult: The Neches River rose-mallow is endemic to relatively open habitat of the Pineywoods (or Timber belt) of east Texas, within Cherokee, Houston, Harrison, and Trinity Counties, and has been introduced into Nacogdoches and Houston Counties. It is known from seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands, with hydric alluvial soils (loamy to clayey). An open canopy is typical, but plants also grow in partial sun. Sites are both perennial and intermittent wetlands with water levels between sites varying due to their proximity to water, amount of rainfall, and floodwaters. Intermittent wetlands are inundated during the winter months but become dry during the summer months (USFWS, 2013a).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Neches River rose-mallow seeds are likely to be dispersed by flowing water. Research has not been done to identify methods of seed dispersal upstream; however, avian species may facilitate this process (USFWS, 2013a).

***Population Information and Trends***

**Number of Populations:**

11 ( 8 natural; 3 introduced) (USFWS, 2018)

**Population Size:**

Approximately 2200 - 2500 individuals (NatureServe, 2015)

**Minimum Viable Population Size:**

At least 10 viable populations of the rose-mallow, each containing an average of about 1,400 individuals (USFWS, 2018)

**Population Narrative:**

When the species was listed in 2013, 11 populations were determined to be occupied by the rose-mallow. Of those 11 populations, 3 sites have not been verified in over 20 years and 3 included introductions on the Davy Crockett National Forest. In addition to these natural populations, the Service is also aware of 8 reintroductions, introductions, or display gardens, some of which were coordinated through the Service. (USFWS, 2018)

### *Threats and Stressors*

**Stressor:** Habitat destruction or modification (USFWS, 2013a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A primary threat to the Neches River rose- mallow is the ongoing encroachment of nonnative and native woody species into its generally open, intermittent or perennial wetlands. Altered hydrology (including beaver dams) can have huge impacts on habitat since this species is water-dependent. Right-of-way populations are vulnerable to bridge and road expansion, new road construction, and upgrade projects, which could impact the sites' hydrology, soil stability, wetland and riparian vegetation, and water quality. Conversion of wetlands to silvicultural uses and associated herbicide use to remove unwanted vegeation is a threat. Habitat damage from trampling by feral hogs and cattle is also a threat, as is drought periods possible related toc limate change (USFWS, 2013a).

**Stressor:** Predation (USFWS, 2013a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mammalian herbivory has affected the majority of sites; however, grazing pressures are largely attributed to the lack of other available food resources during periods of drought. Neches River rose-mallow recovers quickly from herbivory incidents and can produce secondary growth, minimizing the overall negative effects of mammalian herbivory. This type of herbivory is not considered to be a threat to the species. Insect herbivory was also observed on several of the sites and was not rangewide, but, with anticipated climate change shifts in temperature and the likelihood that insect populations will increase, the Services conclude that insect predation is a minor stressor that will likely continue into the future, but it is not a threat to the species (USFWS, 2013a).

### *Recovery*

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 8

**Delisting Criteria:**
A Recovery Plan has not been developed.

**Recovery Actions:**
- A Recovery Plan has not been developed.  The following present the summary statement of recovery needs presented in the 2018 Recovery Outline. (USFWS, 2018)
- - Survey sites that have not been visited in over 20-30 years and determine if they contain the physical and biological features of habitat. - Engage landowners to conduct conservation and stewardship on their property. - Using current niche mdels to identify other areas of potential habitat for rose-mallow and plan to  conducty surveys at those sites. Niche models can also be used in future scenarios where climate change might alter the species current

range (i.e. range expansion). - Consider introductions and reintroductions that would further the representation and resiliency of the rose-mallow across its range, but that are also in-line with the species' propagation and reintroduction plan. - Communicate with partners, academics, nurseries, and plant communities about proper introduction procedures and encourage collaboration with the Service. - Continue to monitor existing populations for threats. - Conduct key biological studies to better understand the species reproductive needs (i.e. longevity, seed dispersal, age structure). This information can inform the recovery targets and needs in a recovery plan. - Develop a species Recovery Plan in FY2020. (USFWS, 2018)

- Not available.

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# SPECIES ACCOUNT: *Hoffmannseggia tenella* (Slender rush-pea)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** SRP

**Listing Status:** Endangered; 12/02/1985; Southwest Region (Region 2)

**Physical Description**

Hoffmannseggia tenella is a perennial legume (Fabaceae: pea family) with spreading stems 8-15 cm long terminating in 3-5 flowered, eglandular inflorescences and having a long woody taproot. Leaves are bipinnately compound with petioles to 13 cm long; leaflets are oblong, 2-4 mm in length, and 1-2 mm broad in 5 or 6 pairs on each of 3-7 pinnae. Flowers are orange and approximately 5 mm long with 10 stamens. Filaments have retrorse hairs. The legumes are 12-15 mm long, 4-6 mm broad and contain 2-4 seeds. Flowering usually occurs from early March to June, sporadically thereafter depending on rainfall (USFWS, 1985b; Mahler, 1982). (USFWS, 1988)

**Taxonomy**

Slender rush-pea is in the class Magnoliopsida, order Fabales, and family Fabaceae (Poole 1988). There are currently no other scientific or common names for this species (Poole 1988). Although the final rule (FR) listed SRP as belonging to the pea family, Fabaceae, it was later listed under the family Leguminosae. These two family names are used interchangeably. Family Fabaceae is the more widely accepted classification for legumes like the SRP. In addition, the International Union for Conservation of Nature and Natural Resources (IUCN) clarified the correct spelling of the genus as Hoffmannseggia, not Hoffmanseggia (USFWS 1985). (USFWS, 2008)

**Historical Range**

Historically known from Nuceces and Kleberg Counties, Texas.

**Current Range**

In Texas, extending from Robstown, Nueces County, on the most northeastern extent of the range to east-central Kleberg County, then west to a point near Kingsville, and north to the vicinity of the Nueces/Jim Wells County line, encompassing approximately 221,000 acres. (USFWS, 2008)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2008)

**Breeding Season**

Adult: March to June (USFWS, 2008)

**Reproduction Narrative**

Adult: The SRP has monoclinous flowers, bearing both male and female reproductive parts in the same flower (Poole 1988). The species appears to be reproductively active during the spring and summer months, however this activity can be prolonged into the fall in a sporadic fashion in response to rainfall events, even if the prevailing climatic conditions are dry (Mahler 1982a, Bush 1990). Fruiting dates are documented from February through July (USFWS 1988) and seed/fruit dispersal dates from March through June (Mahler 1982a). (USFWS, 2008)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland/herbaceous (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Prefers sparsely vegetated areas (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Patches (USFWS, 2008)

**Environmental Specificity**

Adult: Low (inferred from USFWS, 2008)

**Habitat Narrative**

Adult: Slender rush-pea occurs in the eco-region known as the Gulf Prairies and Marshes biotic zone (Correll and Johnston 1970). All documented SRP sites occur in patches of short-grass native prairies adjacent to intermittent or permanently flowing creeks, with the exception of the two most southeastern Kleberg County populations described by Jones in 1964 as being in a “pasture opening on clay loam” and on a “clayey roadside” (TNDD 2007). This species if found in sparsely vegetated openings within bluestem-sacahuista grasslands on heavy clay soils of the South Texas Coastal Plain. The SRP occurs in areas of Victoria Clays which are calcareous, crumbly, clay soils that are self-mulching and greatly cultivated for crops. This species is a perennial legume that occurs in patches of native short- and mid-grass prairie adjacent to watercourses, such as permanent and intermittent creeks. This species is a member of the lower seral stages of succession, perhaps even a pioneer species” or an invader species of highly disturbed soils where it persists until crowded out by other species. (USFWS, 2008; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Not available.

**Number of Populations:**
8 (USFWS, 2018)

**Population Size:**
>10,000 (NatureServe, 2015)

**Population Narrative:**
As a result of work funded through a 2008-2010 Preventing Extinction cooperative agreement and other monitoring efforts, 8 populations were found to be extant (Table 5), although four of these (Hwy 77, St. James Cemetery, Bishop City Park, and a private residence in Bishop) are less than 2.5 km (1.6 miles) apart from the others and probably function as a single metapopulation. Three of the eight (Sablatura County Park, Bishop City Park, and a private residence between St. James Cemetery and Bishop City Park) are new discoveries, and the Petronila site has been temporarily recovered through suppression of the nonnative grass Kleberg bluestem with grassspecific herbicide. Although the King Ranch training area (KRTA) sites have not been visited since 1993, the populations (probably subpopulations of another metapopulation) are likely extant since we have no knowledge that habitat has been disturbed to the point that it is not suitable for rush-pea. (USFWS, 2018)

***Threats and Stressors***

**Stressor:** Habitat alteration (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, conversion of native prairie to row crops and improved pasture was probably the largest factor contributing to losses of SRP populations and habitat (Poole 1988). The range of SRP has likely been considerably contracted by these types of land conversion activities in Nueces and Kleberg counties. Slender rush-pea populations were probably reduced in size or eliminated altogether as habitat was converted to cropland or deliberately planted to monoculture pastures of non-native grasses. Increased cover by woody species may also have impacted some SRP habitat (USFWS 1988). (USFWS, 2008)

**Stressor:** Non-native plants (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** More recently, threats to the integrity of the remaining habitat have increased as non-native pasture grasses, including Kleberg bluestem, King Ranch bluestem, Coastal Bermudagrass, and other introduced grasses have continued to spread throughout this region (Mahler 1982a, Poole 1988, Kuvlesky et al. 2002). These grasses are opportunistic species, either producing copious amounts of seed that can be spread both deliberately and/or inadvertently, or spreading rapidly by vegetative means. Seeding of highway and pipeline ROWs and highways to reduce erosion has helped to increase the distribution of some of these non-native grasses into the native prairie remnants that constitute natural habitat for SRP, as seen at the Petronilla Creek and Highway 77 ROW sites (Poole 1988). The condition of short-grass prairie habitat within the

unplowed rangeland in Kleberg County is not known. Prescribed winter burns and cattle grazing are the primary land management known to occur in this area.Non-native, pasture grasses, predominantly Kleberg bluestem, King Ranch bluestem (Bothriochloa ischaemum), and Coastal Bermudagrass (Cynodon dactylon), have encroached and altered the composition of the native vegetation community at the three accessible SRP population sites at Petronilla Creek/Highway 70, Highway 77 ROW, and St. James Cemetery (Mahler 1982a, Poole 1988, D. Price pers. comm. 2006). These non-native grasses tend to produce dense monocultures with few short-grass native species able to persist (Mahler 1982a). Woody species, including honey mesquite (Prosopis glandulosa), huisache, retama, and others have also become more prevalent in the remnant prairie fragments where SRP persists (Mahler 1982a, USFWS 1988, Ruth 2000). Kleberg bluestem, native to India, China, North Africa, and Egypt, is considered highly competitive, with long creeping rhizomes and continual seed production throughout the year under favorable conditions. Drought tolerance has enabled people to use this grass as a stabilizer on roadsides and pipeline ROWs, and seeds are highly mobile by several means of transport (Drawe 2004). The shallow, fibrous roots of many grass species such as Kleberg bluestem allow quicker absorption of moisture and nutrients than is capable by tap-rooted species, such as SRP, which must wait for deeper moisture penetration (D'Antonio and Mahall 1991).In addition to subsurface competition, fast growing non-native grasses can spread quickly and potentially out-compete SRP for both space and sunlight (Pressly 1998). Greenhouse shadecloth studies using SRP plants grown at the Kika de la Garza PMC demonstrated significant differences in petiole heights and lengths between non-shaded (controls) verses shaded treatments and also differences in the growth pattern (Pressly 2002). Non-shaded plants grew in a prostrate manner while the petioles of the shaded plants grew upwards (Pressly 2002). However, this greenhouse study did not show significant mortality of SRP at 30%, 40%, or 50% shading (Pressly 2002). (USFWS, 2008)

**Stressor:** Disturbances from construction and maintenance (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Localized disturbances causing losses of individual SRP plants have been attributed to highway construction projects as well as ROW maintenance procedures, maintenance of gas pipelines, and excavation of burial plots (Poole 1988). Survey reports indicated some damage to SRP individuals at St. James Cemetery caused by mowing with blades set low to the ground. Other observations at the cemetery reported on damage associated with equipment tracking through the population, and from piling of cleared brush on top of SRP. Consequently, TPWD recommended mowing at a height of no less than 6 inches (approximately 15 cm), which has been incorporated into cemetery groundskeeping procedures (Perez 1992). Also, a management agreement between TxDOT and TPWD included recommendations to continue established mowing practices on the Highway 77 ROW with a full-width mowing 4 times a year and a strip mowed every 6 weeks between May through December. (USFWS, 2008)

**Stressor:** Grazing (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This was not known as a threat at the time of listing. Poole (1986) did observe that 4 SRP plants at the Petronilla/Hwy 70 population “looked as though rabbits had been biting them.”

However, no other evidence, anecdotal or otherwise, exists regarding the effects of grazing or browsing on this species. Data on abundance and distribution of cottontails (Sylvilagus floridanus) and jackrabbits (Lepus californicus) in Nueces and Kleberg counties is lacking; however, it is possible that rabbit populations may have become more concentrated in the remnant strips of habitat in Nueces County. Plants may be susceptible to insect vectors and/or grazing effects, but no research has been conducted to document such effects. No new information regarding the predation or disease of SRP has been found. (USFWS, 2008)

**Stressor:** Herbicide Use (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbicide Use (USFWS, 2022)

***Recovery***

**Reclassification Criteria:**
Downlisting Criteria 1: To downlist rush-pea, 15 populations should have an estimated 1,500 mature individual plants per population. Downlisting may be possible if each of these populations is stable or increasing over the next 35 years. The extant populations (eight total), as well as any that may be restored, augmented, or created, should be maintained with at least five natural populations located in the drainage systems (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins) where the species is known to naturally occur to ensure genetic representation. (USFWS, 2018)

Downlisting Criteria 2: Each rush-pea site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie habitat should contain species commonly associated with rush-pea (see Table 7 of 2018 Recovery Plan). Prolific and aggressive nonnative grasses should not constitute more than small patches within each high quality shortgrass prairie site and invasive grasses and woody species should not be spreading throughout the site or inhibiting growth and reproduction of rush-pea. Each rush-pea site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat conditions and to minimize and control threats over a period of 35 years. (USFWS, 2018)

Recovery Priority Number: 2

**Delisting Criteria:**
Delisting Criteria 1: A minimum of 20 populations are necessary for delisting and should have at least 1,500 mature individual plants per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 60 years. All existing populations, including those that have been restored, created, or reintroduced, are protected and a minimum of five natural populations are extant within each drainage system (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins). (USFWS, 2018)

Delisting Criteria 2: Populations will be protected long-term (protection in perpetuity being optimum) through fee title acquisition, conservation easements, or conservation or management agreements. Species-specific, USFWS-approved annual monitoring and management plans will guide these efforts. Each population site should have high quality shortgrass prairie habitat (see Downlisting Criteria 1 for a description). (USFWS, 2018)

**Recovery Actions:**

- 1. Habitat protection and management of all known population sites of Slender rush-pea in the United States. - Establish positive working relationships with landowners and land managers of all known sites. Maintain contact with all landowners or land managers each year. Educate landowners about the extreme rarity and significance of both the ecosystem and species on their property. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, conservation easements, and conservation agreements. - Cooperate with landowners and land managers to develop and implement management plans that address landowner and species goals. With willing landowners, determine short- and long-term land use goals and their effects on Slender rush-pea. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management. - Enforce applicable laws and regulations. Work with regulatory agencies (DOD– NASK, TXDOT, TPWD, USDANRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat. (USFWS, 2018)
- 2. Monitor Slender rush-pea on an annual basis. - Use the approved monitoring plans to annually monitor rush-pea, its habitat, management actions, and threats at extant sites. - Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites. (USFWS, 2018)
- 3. Initiate studies to gather biological information needed for effective management and recovery of rush-pea. - Determine specific habitat requirements (specifically limiting factors). Study soils and underlying geology. Determine the plant community structure for Slender rush-pea. Study community dynamics/ecology. - Study population dynamics. Analyze the demographic structure of all populations. Characterize phenology and assess the most vulnerable stages of life cycle. Determine the primary means of reproduction in the wild. Study pollination biology and determine effective pollination requirements and effective pollinators. Study seed production and dispersal. Study seedling recruitment. Study population genetics to determine the genetic diversity within and among populations. (USFWS, 2018)
- 4. Survey for additional populations of rush-pea. As more information about the habitat and biology of the species becomes available, determining areas capable of supporting the species may be more predictable. Models, maps, and other tools will be developed showing the vegetative and edaphic characteristics of occupied sites. This information will help to determine where coastal shortgrass prairie habitats currently might remain intact and/or where the species could be located. These potential areas are a high priority to survey and engage in stewardship efforts. These surveys should be performed to locate existing and new populations and for use as potential reintroduction sites in Texas. (USFWS, 2018) (USFWS, 2018)

- 5. Cooperatively work with landowners and land managers to restore additional shortgrass prairie sites located in one or more of the drainage areas from which rush-pea is known to co-occur. (USFWS, 2018) (USFWS, 2018)
- 6. Establish seed or propagule banks and ex-situ (botanical garden, refugium, research institute, etc.) populations for the species. These banks and ex-situ populations will be established using approved reintroduction plans for Slender rush-pea (see Recovery Action 7 below). (USFWS, 2018)
- 7. Conduct a reintroduction program on public and private lands where there are willing partners. Evaluate and document the success of different cultivation techniques, site preparation, and other management techniques based on research, and assess any additional information necessary to attempt reintroduction. Reintroduced populations for Slender rush-pea should not be considered successful until they are established, reproductively active, self-perpetuating, and demonstrated to be demographically and genetically viable. (USFWS, 2018)
- 8. Develop an education and outreach program. Develop any necessary educational or outreach materials. Provide educational and outreach materials to landowners and land managers. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.
- 9. Conduct Population Viability Analyses (PVA) and update the existing MVPs for the species based on current biological and ecological information. Investigate Slender rush-pea’ population genetics to ensure long-term persistence. Develop traditional MVP estimates for Slender rush-pea. Reassess the MVP size when new information is made available. (USFWS, 2018)
- 10. Review and track recovery. Maintain the STXPRT to help review the status of Slender rush-pea and assess the effectiveness of the management plans and other recovery tasks. Revise the Recovery Plan as appropriate. Develop a post-delisting monitoring plan when appropriate. (USFWS, 2018)
- Continued loss and degradation of habitat due to invasion by non-native, fast-spreading grasses is the most pressing threat to the continued existence of SRP populations at sites in Nueces County. There is an immediate need to implement and experiment with management actions involving mowing treatments, selective applications of herbicides, hand removal, and potentially even prescribed burning to control exotics at the cemetery and the Highway 77 ROW sites. Monitoring of SRP response will be needed to document effectiveness of various management techniques. Effective methodologies should be incorporated into management plans for both populations. Annual monitoring should be carried out to determine if populations are stable, increasing, or declining. The Service and/or TPWD should establish a cooperative agreement with the cemetery owner to assist the landowner in implementing the management plan. Based on the results of SRP’s response to various management treatments, TxDOT should consider changes to their management of the Highway 77 ROW, including changes to mowing schedules. (USFWS, 2008)
- A systematic approach to surveying for new populations is needed, particularly in Kleberg County where the natural habitat is potentially in better condition. If additional populations are located in rangeland settings, the effects of prescribed burns on SRP should be analyzed. (USFWS, 2008)

- A reintroduction plan should be established for the SRP to allow experimental plantings into natural habitat, particularly at the former population sites on the western side of the Highway 77 ROW and at the Petronilla Creek/Highway 70 ROW. The SRP has proven to be easily germinated from untreated seed and prospects seem good for propagating the species. A thorough genetics analysis of SRP is needed to develop a sound reintroduction plan. (USFWS, 2008)
- Knowledge regarding species' habitat requirements, population biology, and population ecology needs to be gathered and analyzed in order to develop down-listing and delisting recovery criteria. Additional research needs include determination of habitat requirements, demographic trends, population biology, reproductive biology, and pollinators. (USFWS, 2008)
- The recovery plan for SRP needs to be revised to incorporate all new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria that relate directly to the 5 listing factors should be developed. (USFWS, 2008)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The 2018 Recovery Plan includes actions that are needed to recover the slender rush-pea. The status of the species is still precarious, and we continue to recommend all the actions be implemented and that conservation partners actively seek funding to implement the actions (USFWS, 2022).

**References**

USFWS. 1988. Slender Rush-pea (Hoffmannseggia tenella) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Austin Ecological Services Field Office. 25 pp. July 11, 2008. https://ecos.fws.gov/docs/five_year_review/doc1920.pdf

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

USFWS. 2008. Slender Rush-pea (Hoffmannseggia tenella)

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

USFWS. 2022. Slender rush-pea (Hoffmannseggia tenella) 5-Year Review: Summary and Evaluation. Texas Coastal Ecological Services Field Office. Corpus Christi, Texas. 7 pp.

# SPECIES ACCOUNT: *Holocarpha macradenia* (Santa Cruz tarplant)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An annual herb with stiffly spreading stems that are bristly and glandular. Inflorescence dense with heads in the upper axils; flowers yellow; phyllaries gland-tipped (NatureServe, 2015).

**Taxonomy**

A member of the aster family (Asteraceae). Holocarpha macradenia is one of only four species of the genus Holocarpha, all geographically restricted to California (USFWS, 2014).

**Historical Range**

Historically, habitat for Holocarpha macradenia occurred on grasslands and prairies found on coastal terraces in elevations below 330 feet (100 m), from Monterey County, north to Contra Costa and Marin Counties (USFWS, 2014).

**Current Range**

Holocarpha macradenia occurs in coastal grasslands and prairies in Contra Costa, Santa Cruz, and Monterey Counties, California (Service 2000) (USFWS, 2014).

**Critical Habitat Designated**

Yes; 10/16/2002.

**Legal Description**

On October 16, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Holocarpha macradenia (Santa Cruz tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in California (67 FR 63968-64007).

**Critical Habitat Designation**

The critical habitat designation for Holocarpha macradenia includes eleven CHUs in Contra Costa, Santa Cruz, and Monterey Counties, California. This species critical habitat encompasses approximately 2,902 acres (ac) (1,175 hectares (ha)) (67 FR 63968-64007).

Unit A: Mezue: Unit A consists of grassland habitat on sloping alluvial deposits from old marine terraces within Wildcat Regional Park in Contra Costa County. This entire unit of approximately 50 ha (130 ac) is on lands managed by the EBRPD. Management activities at this site include controlled grazing, removal of invasive artichoke thistle, and annual population monitoring (EBRPD 1992, 2001). Of the 22 sites that were used as sites to introduce Holocarpha macradenia seed in the East Bay region between 1982 and 1986, this population has been the only one that has consistently supported a large population of H. macradenia. In the year 2000, this population supported over 17,000 individuals (CDFG 2000). Although this population is an introduced population, this unit is essential to the survival and conservation of the species because this population represents the genetic variability in the northernmost portion of the plant’s range and is important for the expansion of the existing population. In recognition of the conservation value of this population, the Service is contributing funding toward nonnative species removal at this site (Service 2002).

Unit B: Graham Hill: Unit B consists of grasslands on a relatively flat coastal terrace prairie on the west side of Graham Hill Road, approximately 1 mile north of the City of Santa Cruz in Santa Cruz County. This entire unit of approximately 12 ha (30 ac) is on privately owned lands. The unit includes a 7-ha (17-ac) area that has been set aside through a conservation easement to the County of Santa Cruz for conservation of coastal prairie habitat and Holocarpha macradenia as mitigation for an adjacent development that comprises 52 residences and associated amenities. The population has been fenced and nonnative species have been removed; however, efforts to enhance the population, as called for in a management plan (Environmental Science Associates 1996), have not yet been initiated. In 1994, this population numbered 12,000 individuals; by 1998, 675 individuals were counted; and in 2001, approximately 550 individuals were counted (V. Haley, consultant, Felton, California, pers. comm., 2001). This unit is important because it currently supports a population of H. macradenia and because it represents the western limit of the cluster of populations that are found on the northern end of Monterey Bay. This unit, along with the Fairway Unit, occurs at the highest elevation of the native populations (122 m (400 ft)) and consequently the farthest away from the influence of the coastal climate. Preserving the genetic variability within the species that has allowed it to adapt to these different environmental conditions is essential for the long-term survival and conservation of the species.

Unit C: De Laveaga: Unit C consists of grasslands on a relatively flat coastal terrace prairie within De Laveaga Park just north of the City of Santa Cruz in Santa Cruz County. This entire unit of approximately 2 ha (5 ac) is on State lands managed by the CANG and supported by Federal funds from the National Guard Bureau. The CANG does not anticipate undertaking any new military activities on this parcel beyond its current use as an assembly point for monthly drills and as storage for equipment. In 2001, a maintenance crew from the adjacent city-owned golf course spread wood chips from a felled tree over half the population. The CANG has initiated management actions to restore and enhance habitat for H. macradenia, including removal of the wood chips and chunks of eucalyptus logs. In addition, the CANG has initiated development of an INRMP (CANG 2002); if the final plan meets the criteria outlined earlier in our response to comment number eight, the critical habitat designation may be removed from this unit in the future. This unit is essential because it currently supports a population of H. macradenia and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. Despite its small size, this unit is essential because it is located between the Graham Hill, Arana Gulch, and Rodeo Gulch Units, and is important for maintaining connectivity between these other units.

Unit D: Arana Gulch: Unit D consists of grasslands on a relatively flat coastal terrace prairie within an open space preserve just north of Woods Lagoon in the City of Santa Cruz. This entire unit of approximately 26 ha (65 ac) is on lands owned and managed by the City of Santa Cruz. It is bounded on the west, east, and north sides by existing development and on the south side by the Santa Cruz Harbor. Huge population fluctuations have occurred on this site, ranging from 100,000 individuals in the late 1980s when the site was being grazed by cattle, to no plants in 1995 (K. Lyons, in litt., 2001). The City entered into a Memorandum of Understanding with the CDFG in 1997 to manage Holocarpha macradenia, which includes utilizing a variety of management techniques to enhance the population. As of 1998, individuals numbered approximately 12,820; in 2000, they numbered 234; and in 2002 they numbered approximately 10,000 (K. Lyons, in litt., 2001; Seals 2002). This unit is essential because it currently supports a population of H. macradenia and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. This unit and the Twin Lakes Unit occur at the lowest elevation of the native populations in the northern Monterey Bay area (12 to 18 m (40 to 60 ft)) and are consequently the closest to the influence of the coastal climate. Moreover, these two units are within one-half mile of each other and therefore could retain connectivity between them. It is also essential for the recovery of the species because current management by the City of Santa Cruz has allowed this site to support the third largest standing native population of tarplant. It therefore contributes significantly to the seed bank reserve for the species and is large enough to support management activities that may be necessary to maintain the population at this site.

Unit E: Twin Lakes: Unit E consists of grasslands on relatively flat coastal terrace prairie just north of Schwan Lagoon within the City of Santa Cruz. This entire unit of approximately 11 ha (26 ac) is on lands owned by the CDPR within Twin Lakes State Park. It is bounded on the west, north, and east sides by existing development, and on the south side by Schwan Lagoon. Since 1997, CDPR has been actively managing Holocarpha macradenia habitat by removing invasive, nonnative species and attempting various methods of enhancing the population (Service 2000). CDPR has also funded research on H. macradenia seed bank dynamics (Bainbridge 1999). This population has ranged in size from 120 individuals in 1986 to 21 individuals in 2002 (Hyland 2002). This unit is essential because it currently supports a population of H. macradenia and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. As with the Arana Gulch Unit, it occurs at the lowest elevation of the native populations in the northern Monterey Bay area (12 to 18 m (40 to 60 ft)) and consequently the closest to the influence of the coastal climate. Moreover, the two units are within onehalf mile of each other and therefore could retain connectivity between them.

Unit F: Rodeo Gulch: Unit F consists of sloping alluvial deposits and adjacent relatively flat coastal terrace prairie that straddles the Arana Gulch and Rodeo Gulch drainages north of the community of Soquel in Santa Cruz County. It is bounded on the north, east, and south sides by existing development; the western side is bounded by lands that have not been developed. This entire unit of approximately 11 ha (26 ac) is on privately owned lands. This unit includes a parcel that has recently been proposed for a housing development known as Santa Cruz Gardens Subdivision Unit 12 (Denise Duffy and Associates 2001). This parcel was previously set aside in a ‘‘temporary open space easement’’ as mitigation for destroying a portion of the H. macradenia population by an earlier phase of the development in 1986 (Service 2000). The current development proposal calls for setting aside approximately 23 ha (56 ac) for conservation and recreation purposes, and includes much of the habitat that supports H. macradenia. Salvage of soil and an H. macradenia seed bank is being proposed for another portion of the project site that will be impacted by development (Lyons 1999). This population numbered approximately 60 individuals in 1993; none have been observed since then (CNDDB 2001). However, a seed bank likely persists at this site. This unit is essential because of the likely presence of an H. macradenia seed bank and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. In addition to the seed bank for this population, this unit supports grassland habitat that provides for future expansion of the population. Also, it is within one-half mile of the Soquel Unit, and therefore could retain connectivity between the units.

Unit G: Soquel: Unit G consists of grasslands on sloping alluvial deposits and adjacent relatively flat coastal terrace prairie that straddles the Rodeo Gulch and Soquel Creek drainages north of the community of Soquel in Santa Cruz County. It is bounded on the north, east, and south sides by existing development; the western side is bounded by lands that have not been developed. Approximately 22 ha (55 ac) of this 40- ha (100-ac) unit is within Anna Jean Cummings Regional Park (also known as O’Neill Ranch), which is managed by the County of Santa Cruz. The remaining portion is privately owned. On the park lands, the population has been fenced, and portions of the habitat for the plant are being mowed and raked in accordance with a management plan (Ecosystems West 1999; Joe Rigney, consultant, pers. comm., 2001). The County of Santa Cruz approved a housing development for the privatelyowned parcel (previously known as Tan, but now called Seacrest) in 1997. The development included an approximately 4-ha (10-ac) parcel to be set aside for conservation and a plan to manage the habitat for Holocarpha macradenia. Although part of the same population, the CNDDB has maintained two separate entries (O’Neill and Tan) to reflect the two land ownerships. The total number of individuals in the combined population has never been larger than 200 individuals, with the private parcel supporting only a portion of those (CNDDB 2001). To date, management activities have not resulted in enhancing the population of the species on either parcel. This unit is essential because it has recently supported a population of H. macradenia and the seed bank is still present, and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. In addition to the seed bank for this population, this unit supports grassland habitat that provides for future expansion of the population. Also, it is within one-half mile of the Rodeo Gulch Unit, and therefore could retain connectivity between the units. Moreover, the acreage in Anna Jean Cummings Park represents one of the best remaining fragments of habitat on which to attempt recovery activities for H. macradenia, as it has been subject to fewer impacts than other sites.

Unit H: Porter Gulch: Unit H consists of grasslands on gently sloping alluvial deposits derived from a coastal terrace that straddles the Bates Creek and Porter Gulch drainages north of the community of Soquel in Santa Cruz County. It is bounded on all sides by undeveloped lands. This entire unit of approximately 14 ha (35 ac) is on privately owned lands. The population of Holocarpha macradenia at this site includes an approximately 12-ha (30-ac) parcel that was proposed for a lot split. A management plan for the species was developed as part of the proposed split (Greening Associates 1995); however, the management plan for H. macradenia has not been fully implemented. This unit also includes adjacent coastal prairie habitat, of which approximately 4 ha (9 ac) was deeded in 2001 to the Land Trust of Santa Cruz County for preservation. In 1993, the population of H. macradenia numbered approximately 1,500 individuals (CNDDB 2001). The population numbered only several hundred individuals in 2001 when the site was observed to support a large cover of rattlesnake grass that likely competed with H. macradenia (C. Rutherford, Service, pers. obs., 2001). This unit is essential because it currently supports a population of H. macradenia, and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. Also, along with the Graham Hill Unit, this one occurs at the highest elevation of the native populations (122 m (400 ft)) and consequently the farthest away from the influence of the coastal climate. Preserving the genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species.

Unit I: Watsonville: Unit I consists of grasslands on alluvial fans and marine terraces west of the City of Watsonville in Santa Cruz County; during the remapping for the final rule we removed most of the lowlying drainages that interdigitate with the grasslands. The northern and eastern boundaries reach toward the Corralitos Creek drainage except where it runs up against existing development. The southeastern and southern boundary is formed by the Pajaro River drainage. The western boundary is formed by the Harkins Slough drainage and then generally follows Buena Vista Drive north until it intersects with the northern perimeter of the Watsonville Airport (Airport). This unit excludes paved areas of the Airport, but includes the unpaved portions surrounding the runways. This approximately 488-ha (1,205-ac) unit is partly owned by the City of Watsonville (the Airport and High School) (approximately 125 ha (309 ac)); a small portion is under easement to CalTrans (approximately 8 ha (19 ac)); a portion is designated as a Reserve by the CDFG (approximately 15 ha (37 ac)); and the remaining portion is privately owned (approximately 340 ha (840 ac)). This unit overlaps in part with an area that is targeted for regional conservation planning by the CDFG. Through its Conceptual Area Protection Plan process, CDFG, along with other Federal, State, and local agencies and organizations, are identifying opportunities to preserve sensitive species and habitats, including the Harkins Slough and Watsonville Slough wetlands and adjacent habitats (J. DeWald, in litt., 2001). This unit is essential because it currently supports multiple populations of H. macradenia including the populations known from the Airport, Harkins Slough, Apple Hill, and Bay Breeze (see Background for additional population information). This unit also supports grassland habitat that is important for the expansion of existing populations and for maintaining connectivity between the populations. It is also one of only three areas that support populations of H. macradenia that are found in the central Monterey Bay area and in the southern end of the range of the species. Preserving any genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species. Just prior to publication of this final rule, we were informed that construction of the Millennium High School had been initiated. Therefore, with this unit description, we are removing the 32 acres that are being converted to building, paved surfaces, and playing fields because these areas will no longer support the primary constituent elements. Note, however, that the 32 acres have not been removed from the map depicting this unit; nor have they been subtracted from the unit total and overall total number of acres being designated as critical habitat for the species.

Unit J: Casserly: Unit J consists of open patches of grassland interspersed with golf course greens, cattle pastures, croplands, and orchards. This entire unit of approximately 450 ha (1,110 ac) consists of privately owned lands. It is the unit for which the least amount of information is available, particularly with respect to existing land uses. The Spring Hills population of Holocarpha macradenia occurs within this unit. The population numbered approximately 4,000 individuals in 1990 (CNDDB 2001); the population was observed in 1995 and 2001, though not counted. The population was fragmented by development of the Spring Hills Golf Course, and now consists of five separate occurrences. This unit is essential because it currently supports multiple occurrences of H. macradenia that are found in the Monterey Bay area, including the five populations known from the Spring Hills Golf Course. This unit also supports grassland habitat that is important for the expansion of existing populations, and for maintaining connectivity between these populations. It is one of only three areas that support populations of H. macradenia that are found in the central Monterey Bay area and in the southern end of the range of the species as well as the most inland distribution of the species. Preserving genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species.

Unit K: Elkhorn: Unit K consists of sloping terrain on the edges of a coastal terrace, just south of the Pajaro River in northern Monterey County. The population of Holocarpha macradenia that is found here is unusual in that it occurs on a canyon bottom; it is also the only population that occurs primarily on the Santa Ynez soil series. This unit of approximately 70 ha (170 ac) is privately owned by the Elkhorn Slough Foundation (Foundation). The CDFG holds a conservation easement on an approximately 16-ha (40-ac) parcel that overlaps in part with this unit; the Foundation is managing the parcel for its biological values. Multiple Federal, State, and local government and private agencies have recently developed a conservation plan for the Elkhorn Slough watershed; this critical habitat unit is within the 18,210-ha (45,000-ac) area on which the conservation plan focuses (Scharffenberger 1999). In 1993, the population at this site comprised approximately 3,200 individuals (CNDDB 2001). Salix spp. (willow) planting that has been undertaken as part of a riparian enhancement project may increase shading on an adjacent population of H. macradenia, leading to a reduction in the size of that population (Holl, in litt., 2002). This unit is essential because it currently supports a population of H. macradenia and because it is one of only three areas that support populations of H. macradenia that are found on the central Monterey Bay area and in the southern end of the range of the species. Also, this is the only population that occurs primarily on the Santa Ynez soil series. Preserving any genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species. In addition to the current population, this unit comprises grassland habitat that is important for the expansion of the population.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Holocarpha macradenia critical habitat consists of three components (67 FR 63968-64007):

(i) Soils associated with coastal terrace prairies, including the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series.

(ii) Plant communities that support associated species, including native grasses such as Nassella sp.(needlegrass) and Danthonia californica (California oatgrass); native herbaceous species such as members of the genus Hemizonia (other tarplants), Perideridia gairdneri (Gairdner’s yampah), Plagiobothrys diffusus (San Francisco popcorn flower), and Trifolium buckwestiorum (Santa Cruz clover); and

(iii) Physical processes, particularly soils and hydrologic processes, that maintain the soil structure and hydrology that produce the seasonally saturated soils characteristic of Holocarpha macradenia habitat.

**Special Management Considerations or Protections**

Much of what is known about the specific physical and biological requirements of Holocarpha macradenia is described in the Background section of this final rule. Additional information about appropriate management techniques is being generated by ongoing management efforts and research on life history. As discussed in the Background section, several agencies such as the CDFG, California Department of Parks and Recreation (CDPR), CalTrans, County of Santa Cruz, City of Santa Cruz, and EBRPD are undertaking efforts to learn how to better enhance habitat for H. macradenia. Some of these efforts are being carried out with the cooperation of researchers from UC Santa Cruz and Berkeley's Jepson Herbarium. Preliminary management and seed bank studies show that habitat manipulation such as burning, mowing, grazing, and scraping can increase standing numbers of plants and may be necessary to enhance and maintain populations of H. macradenia. Active management is often necessary to preserve habitat that is essential for the long-term conservation of H. macradenia. Special management considerations or protections may be needed to maintain the primary constituent elements for Holocarpha macradenia within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of H. macradenia are maintained, and have the ability to reproduce and disperse into surrounding habitat at those sites. In other cases, however, active management may be needed to maintain the primary constituent elements for H. macradenia. We have outlined below the most likely special management or protection that H. macradenia may require. (1) The native soils on which Holocarpha macradenia is found should be maintained to optimize conditions for the species. Physical properties of the soil, such as its chemical composition, salinity, texture, and drainage capabilities would best be maintained by limiting or restricting deep tilling and the use of herbicides, fertilizers, or other soil amendments. (2) The hydrologic regime of the area surrounding Holocarpha macradenia habitat should be maintained to provide for the seasonally moist soils that the species favors. Increasing or decreasing surface and subsurface water flow to these areas through habitat alteration that either artificially adds water (e.g., through irrigation) or reduces water (e.g., through diversions associated with construction projects) could decrease the suitability of these areas to support H. macradenia. (3) The grassland communities should be maintained to ensure that the habitat needs of pollinators and dispersal agents are maintained. The use of pesticides should be limited or restricted so that viable populations of pollinators are present to facilitate reproduction of Holocarpha macradenia. Fragmentation of habitat through construction of roads and certain types of fencing should be sufficiently limited to allow seed dispersal agents to move H. macradenia seed throughout the unit. (4) The grassland communities need to be maintained to facilitate germination and the establishment of seedlings, because this is a critical bottleneck in the life cycle of the species (Bainbridge, in litt., 2002b). In particular, this portion of the species' life cycle requires a reduced litter layer and canopy height of surrounding vegetation. This can be achieved through either mowing or livestock grazing. A discussion of more detailed prescriptions is beyond the scope of this rule, as the optimal regime will vary from site to site, depending on a number of variables. However, research efforts that are currently underway will assist in developing more site-specific recommendations. (5) In the grassland communities where Holocarpha macradenia occurs, invasive, nonnative species such as French broom, eucalyptus, acacia, Harding grass, bromes, artichoke thistle, and bristly ox-tongue and other species need to be actively managed to reduce competition and maintain the open habitat that H. macradenia needs. (6) Certain areas where Holocarpha macradenia occurs may need to be fenced to protect them from accidental or intentional trampling by humans and livestock, and to facilitate management of the habitat through intentional grazing or other means.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2014)

**Lifespan**

Adult: 1 year (USFWS, 2014)

**Breeding Season**

Adult: July - October (USFWS, 2014)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, soil seed bank (USFWS, 2014)

**Reproduction Narrative**

Adult: This is an annual plant. Flowering from July to October, the inflorescences comprise yellow ray and disc flowers. Native bees, flies, wasps, and winged beetles have been observed pollinating H. macradenia (Barber 2002). Plants produce 1 to 60 inflorescences with two types of flowers that produce two types of achenes (seeds) with different morphologies and requirements for germination. Results of studies indicate that disk seeds produced by Holocarpha macradenia germinate within a year of production while ray seeds form persistent seed banks. Holocarpha macradenia is self-incompatible, meaning that individuals will not produce viable seeds without cross pollinating with other individuals (Baldwin, in litt. 2001) (USFWS, 2014).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal prairies and grasslands (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire (USFWS, 2014)

**Geographic or Habitat Restraints or Barriers**

Adult: 10 - 220 m elevation (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits coastal prairies and grasslands, often with clay or sandy-clay soils, at 10 - 220 m elevation. Most frequent associates are non-native grasses and non-native French broom (Genista monpessulana). The environmental specificity is moderate (generalist or community with some key requirements scarce) (NatureServe, 2015). Soils associated with coastal terrace prairies include the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series. Physical processes, particularly soils and hydrologic processes that maintain the soil structure and hydrology that produce the seasonally saturated soils characteristic of H. macradenia habitat, are necessary features for the conservation of the species. Historically, coastal prairie species such as Holocarpha macradenia may have evolved under light grazing pressure and an intense fire regime used by California Native American groups (Heady et al. 1988). Grazing likely improves habitat quality for H. macradenia by removing plant biomass cover, reducing aboveground competition during the growing season, and reducing thatch accumulations that inhibit tarplant germination. Additionally, trampling by grazers can open, roughen, and compact surface layers of soil (USFWS, 2014).

***Dispersal/Migration***

**Dispersal**

Adult: Low; possibly high if dispersed by animals (USFWS, 2014)

**Dispersal/Migration Narrative**

Adult: Most seeds remain on the plant until the first significant rain (0.6-1.2 inches (15–30 millimeters (mm)) in late autumn (Service 2002, Holl and Hayes 2006). Neither type of seed appears to have a structural means for dispersal, and most fall within 17.7 inches (45 cm) of the plant (Holl and Hayes 2006) though it is possible that some ray seeds may be dispersed over long distances by animals (Satterthwaite et al. 2007) (USFWS, 2014).

***Population Information and Trends***

**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

**Species Trends:**

10 - 30% decline (NatureServe, 2015)

**Number of Populations:**

15 native, 4 - 8 experimental (USFWS, 2023)

**Population Size:**

Uncertain, possibly ~25,000 (NatureServe, 2015)

**Adaptability:**

High (inferred from NatureServe, 2015)

**Population Narrative:**

The plant is not terribly vulnerable intrinsically; it is a robust composite that can colonize open areas. Long term trend has been one of substantial decline; 50-70%. The short term trend has been one of steady decline (10 - 30%) due to development. It is difficult to trust some of the population data CNDDB has received. For example, one form stated there were "millions" of plants, which seems doubtful. More solid estimates sent to the CNDDB tend to be from the early 1990's and therefore constitute old information. These add up to about 25,000 plants (NatureServe, 2015). Holocarpha macradenia occurs in 14 native and 4 to 8 experimentally seeded populations (USFWS, 2014). There are currently 19 known occurrences that support Santa Cruz tarplant or are presumed to have a viable seedbank and suitable habitat (Table 1). This is an increase of one occurrence, located on private land, since the 2014 5-year review. Eleven occurrences have regular or periodic monitoring that estimate annual abundance of Santa Cruz tarplant and also have active management and/or reintroduction efforts. The remaining eight occurrences have no monitoring and management efforts, or have ceased monitoring and management since 2014 (USFWS, 2022). At listing, Santa Cruz tarplant was known from 14 natural and 4 to 8 experimentally introduced populations in coastal grasslands and prairies in Contra Costa, Santa Cruz, and Monterey Counties, California (65 FR 14898). Santa Cruz tarplant continues to occur within Contra Costa, Monterey, and Santa Cruz Counties. Currently, 15 natural populations are located within Santa Cruz and Monterey Counties and four experimental populations are located within Contra Costa County (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In Santa Cruz County, coastal prairie habitat was converted to ranching and agricultural lands in the late 1800s and early 1900s; subsequently, this habitat was favored for the expansion of urban centers, especially around the cities of Santa Cruz and Watsonville. California coastal prairies have been affected by humans to the extent that their recovery is extremely slow or even unlikely, and will require human intervention (Stromberg and Griffin 1996; Hamilton et al. 2002, as cited in Buisson et al. 2006). The Apple Hill population is located on a small Caltrans right-of-way. The population was once comprised of three colonies, two of which were extirpated by the construction of a housing development on adjacent private property. The remaining colony occurs on a strip of land between the housing development and Highway 152. The Arana Gulch population and its designated critical habitat will be subject to additional habitat alteration and destruction with the construction of a bike path proposed by the City of Santa Cruz. A portion of the habitat associated with the Watsonville Airport may be subject to additional alteration; a proposed development project would permanently impact approximately 2 acres (0.8 ha) of Holocarpha macradenia critical habitat within the Watsonville critical habitat area (Unit I) (Olberding Environmental 2009). The Winkle population of Holocarpha macradenia, also referred to as the Santa Cruz Gardens population, was partially destroyed by development in 1986 (Arnold and Lyons 2009). Further development has been proposed within a 58.6-acre (23.7-ha) project site that includes the Winkle population (USFWS, 2014).

**Stressor:** Nonnative plants (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Overgrowth of nonnative invasive species is a principal ongoing threat for Holocarpha macradenia populations. Even with management, most populations are in decline due to H. macradenia's inability to compete with the overgrowth of nonnative vegetation. Invasive species that have been identified as threats to H. macradenia populations include but are not limited to: Genista monspessulana (French broom), Foeniculum vulgare (fennel), Eucalyptus spp. (eucalyptus); Acacia decurrens, A. melanoxylon (acacia); artichoke thistle; Rubus discolor (Himalayan blackberry); Phalaris aquatica (harding grass); Festuca arundinacea (tall fescue); Cardaria draba (hoary cress); Carduus pycnocephala (Italian thistle); Picris echioides (bristly ox-tongue); Trifolium angustifolum (narrow-leafed clover); Convolvulus arvense (field bindweed); and Conium maculatum (poison hemlock) (Service 2000, Watsonville Wetlands Watch 2009) (USFWS, 2014).

**Stressor:** Herbivory (USFWS, 2014)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A study by Maze (2009) indicated that invertebrate herbivory on Holocarpha macradenia significantly affected the survivability of H. macradenia seedlings. Most of the herbivory observed in the study was caused by the nonnative grey garden slug (Deroceras reticulatum). Although results of this study indicate that herbivory could potentially be a problem for H. macradenia, or possibly exacerbate other threats to H. macradenia populations, herbivory does not appear to be a significant threat at this time (USFWS, 2014).

**Stressor:** Low reproductive success (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The eight populations of Holocarpha macradenia in Contra Costa County are the result of 22 experimental seedings performed from 1982 to 1986, within Wildcat Canyon Regional Park on East Bay Municipal Utility District land. The 22 experimental seedings have been managed with invasive plant removal and a grazing regime, yet have resulted in only 8 lasting populations, with only one of these populations (Mezue) showing substantial numbers and an increasing trend over time. Additionally, of the 8 remaining populations, data show that only about half of these have had persistent numbers of aboveground plants over the past 10 years (Legard, unpubl. data 2010). Although some seeding attempts have been somewhat successful, it appears that the management, timing, location of plantings, and techniques greatly influence the results of the persistence of Holocarpha macradenia, and long term viability in these cases remains unclear (USFWS, 2014).

**Stressor:** Environmental stochasticity (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Much of the coastal prairie habitat that supports Holocarpha macradenia has been altered, fragmented, or destroyed, so that most of the remaining habitat is of small acreage and supports only very small populations. Because H. macradenia is not capable of self-fertilization, individuals cannot produce viable seeds without cross pollinating with other individuals. Small populations may have a more difficult time attracting pollinators and therefore may experience lower seed production rates, leading to reduced species viability and possible extirpation over time (Service 2000, Satterthwaite 2007). With only 14 naturally occurring populations in a limited portion of its historic range, environmental stochasticity remains a threat to H. macradenia, and is currently a greater threat than it was at the time of listing (USFWS, 2014).

**Stressor:** Climate change (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts to H. macradenia under predicted future climate change are unclear. The potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that species will "move" to higher elevations and northward, depending on

the ability of each species to do so (USFWS, 2014).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 11

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

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- Coordinate a meeting with CDFW and the Elkhorn Slough Foundation, including species experts and managers of Holocarpha macradenia populations, to collaborate on current status of the species, successful management and census techniques, and to continue efforts toward management of the species and conservation of habitat (USFWS, 2014).
- Work with the appropriate governing agencies or landowners to continue and/or improve management for Holocarpha macradenia populations, and initiate programs for populations that do not currently undergo a management regime. Possibilities may include but are not limited to: At Fairway Drive, working with the County of Santa Cruz and the Homeowners Association toward more active long-term management and restoration of habitat and populations; working with the Spring Hills Golf Course to investigate possibilities to restore and manage habitat and populations on their property; at O'Neill/Tan, working with the County of Santa Cruz and private landowners toward more active long-term management and restoration of habitat and populations; at Atkinson Lane, working with PG&E toward the possibility of long-term management and restoration of habitat and populations; at Apple Hill, working with Caltrans to better manage and restore habitat and populations; and at Arana Gulch, working with the City of Santa Cruz toward more vigorous long-term management and restoration of habitat and populations (USFWS, 2014).
- Investigate opportunities for conservation of lands that support suitable habitat for the species and for future outplanting (USFWS, 2014).
- Evaluate suitable habitat for future outplanting, and investigate seeding and transplanting techniques that will lead to large, self-sustained populations (USFWS, 2014).
- Based on research already conducted by Satterthwaite et al. (2007), Bainbridge (2003, 2007), and the California Department of Parks and Recreation (Hyland, unpubl. data 2002, 2004, 2007, 2009), undertake additional research to investigate seed bank dynamics, particularly how to maintain optimal balance between aboveground populations and the seed bank (USFWS, 2014).
- Conduct research to investigate mowing, raking, grazing, and other techniques that are beneficial to Holocarpha macradenia and develop best management strategies, particularly for management of thatch and nonnative species, utilizing these techniques (USFWS, 2014).
- Investigate the impacts of climate change on Holocarpha macradenia (USFWS, 2014).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Identify techniques for successful reintroduction and management. 2. Secure funding for management at currently unmanaged locations. 3. Include habitat restoration as part of reintroduction efforts. 4. Identify mechanisms to promote and

preserve Santa Cruz tarplant on properties susceptible to development (USFWS, 2022).

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# SPECIES ACCOUNT: *Hymenoxys herbacea* (Lakeside daisy)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 06/23/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

**Physical Description**

The Lakeside daisy is a perennial herb with flowering stalks, 5-25 cm tall, arising from basal tufts of leaves. When the plants are not in bloom, the small tufts of leaves are easily overlooked, but in bloom (late April-June, or July in Canada) the plants are extremely showy, with populations simultaneously producing masses of large (3-4 cm in diameter) yellow flower heads. (NatureServe, 2015)

**Taxonomy**

The species was listed as Hymenoxys acaulis var. glabra (USFWS, 1988) and is treated that way in most floras. Based upon the work of Cusick (1991), who noted chromosomal, reproductive, and physical differences between the Lakeside daisy and the original nominate species, the Fish and Wildlife Service recognized the Lakeside daisy as a separate species, Hymenoxys herbacea. More recent treatment is Tetraneuris herbacea (USFWS, 2016). The taxonomic name for Lakeside daisy was Hymenoxys herbacea (Asteraceae). However, more recent treatment is to use Edward Greene's name of Tetraneuris herbacea. This is the name used by the Ohio Department of Natural Resources Division of Natural Areas and Preserves (DNAP), USDA, Center for Plant Conservation, Smithsonian National Museum of Natural History, and it is widely accepted by many other scientific organizations. However, this name has not been widely adopted by the Service. (USFWS, 2021)

**Historical Range**

At the time of listing, the Lakeside daisy was known from only one fragmented population in the U.S., in Ottawa County,  Ohio and from two regions in Ontario, Canada. It was presumed extirpated in Will and Tazewell, County Illinois (USFWS, 2016).

**Current Range**

Currently, the Lakeside daisy is known from sites in Ohio, Illinois, Michigan, and Ontario. It is extant on the Marblehead Peninsula of Ottawa Co., Ohio and in Ontario, Canada on Manitoulin Island and the Bruce Peninsula. The largest populations are in Ontario. Additionally, three introduced populations that are likely not functioning as an ecological community, have been transplanted into appropriate habitat in Erie County, Ohio and in DuPage and Cook County, Illinois. Sites presumed extirpated in Will and Tazewell County, Illinois are now identified as restored populations. The population in Michigan occurs in Brevort Township, Mackinac County (USFWS, 2016). Since the Lakeside daisy was listed as threatened in 1988 (53 FR 23742), the number of populations in the United States has increased from the single large, fragmented population at Marblehead Peninsula in Ottawa County, Ohio. In Michigan two populations were found and three populations were introduced. Additionally, three populations have been restored (two in Will County, Illinois, one in Tazewell County, Illinois). In Illinois three populations have been introduced (two in Cook County and one in DuPage County), two populations were introduced in Michigan (Brevort Lake Road reserve and quarry), and four populations have been introduced in Ohio (three on Kelleys Island and one in Margaretta Township, Erie County). Most populations in Illinois and Michigan appear to be stable, however some, such as the DuPage and Tazewell County, Illinois populations have been declining. (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Obligate outcrosser (self-incompatible), but also reproduces clonally. (NatureServe, 2015)

**Lifespan**

Adult: Unknown, possibly decades (USFWS, 1990)

**Dependency on Other Individuals or Species**

Adult: According to the Recovery Plan, the following types of insects have been observed to pollinate Lakeside daisy: bumble bees (Apidae), small carpenter bees (Xylocopidae), and halictid bees (Halictidae). Recent observations in Ohio, have documented multiple insects visiting and potentially pollinating Lakeside daisy flowers. These include the pearl crescent (Phycoides tharos) (Parshall, Ohio Lepidopterists, personal communication, 2015), a small butterfly, and multiple syrphid flies (Syrphidae) including the transverse-banded flower fly (Eristalis transversa), tufted globetail (Sphaerophoria contingua), and margined calligrapher (Toxomerus marginatus) (USFWS 2021).

**Breeding Season**

Adult: Flowers late April to early June (USFWS, 1990)

**Reproduction Narrative**

Adult: The Lakeside daisy is a perennial that flowers from late April to early June. Although locally variable, an average of 75% of the adult plant population in any given area is in flower during this time. Under optimal greenhouse conditions, plants grown from seed can achieve reproductive size within seven months; in natural populations it may take two to three years (DeMauro 1990). Buds are visible by early spring at the rosette center. Flowers are visited by bumble bees (Dr. R. Betz, pers. obs.), small carpenter and halictid bees (R. Panzer, Northeastern Illinois University, pers. obs.), and the pearl crescent butterfly (USFWS, 2016). It is possible that pollination is also achieved by wind. Outcrossing is necessary for seed production because Lakeside daisy exhibits sporophytic incompatibility within a clone (DeMauro l988a). In natural populations, seed production averages 49 seeds per inflorescence (DeMauro 1988a). The number of inflorescences/plant is positively correlated with plant size and although highly variable, the two are positively correlated (DeMauro l988a). Achenes develop quickly and are wind-dispersed three to four weeks following fertilization. In natural populations, spring and fall seed germination have been observed (DeMauro pers. obs.). Under optimal artificial storage conditions, seeds can remain viable for at least three years (DeMauro unpub. data); in natural populations, it is not known how long seeds remain viable or if there is a seed bank. Although the longevity of clonal colonies is not known, plants can grow up to one meter in diameter; under field conditions it may take on the order of decades to achieve this size. (USFWS, 1990).

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**Habitat Type**

Adult: Alvar habitat (flat limestone or dolostone bedrock with thin to no soil, few to no tress, and subject to seasonal drought) and modified alvar habitat where original habitat has been modified or removed by quarrying activities and is in the form of gravel (USFWS, 2016).

**Habitat Vegetation or Surface Water Classification**

Adult: Limestone or dolomite outcrops (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Thin soils over limestone or dolomite outcrops or soils (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from USFWS, 1990)

**Environmental Specificity**

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

**Site Fidelity**

Adult: High (USFWS, 1990)

**Habitat Narrative**

Adult: The Lakeside daisy requires full sun and occurs on limestone or dolomite outcrops, on thin soils over dolomite or limestone, and on dry limestone prairie soils. It may also occur in openings of forests. It is almost exclusively found on such soils or on bare rocks. Typically, the plains are sandy or gravelly with rocks up to one inch in size or larger. An active quarry with the open, gravelly, limestone habitat has one of the best populations of the daisy. (USFWS, 1990)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Limited (inferred from USFWS, 1990)

**Dispersal**

Adult: Low (inferred from USFWS, 1990)

**Dispersal/Migration Narrative**

Adult: Achenes develop quickly and are wind-dispersed three to four weeks following fertilization, typically in early to mid-June. It is not known how far seeds disperse, however the greatest numbers of seedlings appear within one-half meter of adult plants (DeMauro pers. obs.). (USFWS, 1990)

***Population Information and Trends***

**Population Trends:**

Unknown. Inferred from information (USFWS, 2021)

**Species Trends:**

Unknown. Inferred from information (USFWS, 2021)

**Number of Populations:**

6 - 20 (NatureServe, 2015)

**Population Size:**

200 - 1,000,000 individuals (USFWS, 2016)

**Minimum Viable Population Size:**

Minimum of 5,000 individuals is necessary to maintain the balance between mutation and genetic drift; fewer than 50 individuals will result in loss of self-incompatibility alleles (USFWS, 2016)

**Adaptability:**

Low (NatureServe, 2015)

**Population Narrative:**

The species is locally abundant in good stands. There are extensive, probably millions of clumps, but the number of clonal colonies is unknown and probably far fewer. Overall, the population size is difficult to determine. Naturally occurring populations are known from two sites on Marblehead Peninsula in Ottawa County, Ohio (Lafarge Quarry and Lakeside Daisy State Nature Preserve) and Manitoulin Island and Bruce Peninsula in Ontario, Canada where 24 extant or more localities are known (Ontario CDC, 3/94). The size of the population within the Lafarge Quarry is estimated to be 10.05 million (5.78 juvenile plants and 4.27 adult plants) individuals as of 2015 but 3 million of the adult plants occur in an area planned for imminent mining in the next 3-5 years. The size of the population on the Lakeside Daisy State Nature Preserve is estimated to be 1.4-1.7 million. An introduced population occurs on Kelleys Island in Erie County, Ohio in 1989 that contained over 18,800 adult plants in 2014 and is increasing. Populations in Illinois were presumed extirpated from Will and Tazewell Counties but they have been identified as restored populations although continue to decline with the population in Will County containing less than 200 plants. Introduced populations also exist in DuPage and Cook Counties, Illinois with varying numbers from 64 to over 400 individuals surveyed in recent years. A population was discovered at a single Michigan site in Brevort Township, Mackinac County and is located on lands managed by Hiawath National Forest and the Michigan Nature Association with less than 200 plants. An additional reserve population was established by the Michigan Nature Association and planted in 2010 . These populations occur on a variety of private and federally-owned lands with different levels of protection (USFWS, 2016). Since the Lakeside daisy was listed as threatened in 1988 (53 FR 23742), the number of populations in the United States has increased from the single large, fragmented population at Marblehead Peninsula in Ottawa County, Ohio. In Michigan two populations were found and three populations were introduced. Additionally, three populations have been restored (two in Will County, Illinois, one in Tazewell County, Illinois). In Illinois three populations have been introduced (two in Cook County and one in DuPage County), two populations were introduced in Michigan (Brevort Lake Road reserve and quarry), and four populations have been introduced in Ohio (three on Kelleys Island and one in Margaretta Township, Erie County). Most populations in Illinois and Michigan appear to be stable, however some, such as the DuPage and Tazewell County, Illinois populations have been declining. It is likely that some of the populations categorized as stable may also show declining trends if long-term data were available (USFWS, 2021).

***Threats and Stressors***

**Stressor:** Habitat destruction (USFWS, 2010; 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The limestone or dolomite outcrops on which the daisy occurs are subject to commercial quarrying. Cottage and industrial development may eliminate habitat, while trampling and soil compaction can result from grazing or recreational activities and may impair habitat (NatureServe, 2015). Quarry operations have increased in recent years and have impacted a significant amount of occupied habitat and no additional habitat has been protected nor can alvar habitat be created. A survey conducted in 2015 shows that occupied habitat within the quarry has declined from 400-450 acres to approximately 92.552 acres mostly due to quarry activity. ATV use can destroy plants or habitat, or lead to the introduction of invasive species. Road and powerline right-of-way maintenance including herbicide spraying and snow plowing, may also adversely impact habitat. (USFWS, 2010; 2016) The greatest threat remains the ongoing quarry activities which occur at the largest population in the U.S. (Table 6). Quarry activities since 1989 have reduced the amount of potential habitat for this species. In addition, activities have expanded to the west and south where some of the highest densities of Lakeside daisy previously occurred. LafargeHolcim continues its quarry operations which reduces the amount of modified alvar habitat available. It is anticipated that once quarry operations are complete, the quarry will then naturally fill with water and become a large lake. The only remaining upland habitat would be limited to the periphery. Thus, without permanent protection of alvar and modified alvar habitat, the amount of suitable habitat for this species will continue to decline. (USFWS, 2021)

**Stressor:** Succession (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species requires an open, sunny habitat. Successional growth around forest openings and at the edges male eliminate the open requirement. In some cases, past maintenance of rights-of-way has kept habitat open and needs to continue without herbicide spraying to benefit the species. (USFWS, 2010) Management requirements to maintain suitable habitat for the Lakeside daisy varies at different sites. The populations in Illinois experience

greater vegetative competition, so greater levels of management are needed to maintain open habitat. The Michigan populations are also experiencing some shading by trees, which may require some management to maintain the light levels needed by Lakeside daisy. In Ohio, some removal of cedar, and other woody species, is required to maintain sunny, open alvar habitat. This management is required infrequently. In general, Lakeside daisy is well adapted to occupying alvar habitat that other plants cannot tolerate and therefore competition is limited. (USFWS, 2021)

**Stressor:** Inadequacy of existing regulations (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although laws and regulations exist to protect the Lakeside daisy on most public sites, enforcement is lacking and destruction is still occurring. On private land, the Lakeside daisy is not afforded protection, and some populations are being seriously impacted by quarrying activities. (USFWS, 2010) The inadequacy of state and Federal laws for plant and plant habitat protection remain the same as discussed in the 2016 5-year Review for Lakeside daisy. One recent change is that despite coordination between the Erie County Metroparks and the Service, including an MOU, impacts to this species are still occurring. During 2021 monitoring, Lakeside daisy plants were found pulled from the ground in an area where it appeared that illegal camping had also occurred. In addition, recent actions due to right-of-way work resulted in significant disturbance at the Brevort Township site in Michigan. (USFWS, 2021)

**Stressor:** Self-incompatibility (USFWS, 2010
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The self-incompatibility of the Lakeside daisy requires outcrossing between individuals with different self-incompatibility genes. Populations within larger regions, such as those on Marblehead Peninsula and Manitoulin Island, are likely in contact with many individuals that each has a different self-incompatibility gene. However, small populations tend to lose self-incompatibility genes, increasing the probability of nearby plants sharing the same gene, and therefore reducing the potential to effectively outcross. It is theorized that this may have been a leading factor in the natural disappearance of one of the last Lakeside daisy populations in Illinois (DeMauro 1982). (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change may be a serious threat for a rare, endemic plant species like the Lakeside daisy. The habitat for the Lakeside daisy currently spans a narrow range of habitat types, including dry, limestone prairies and alvar communities, which are globally rare. According to regional precipitation and temperature models, increased temperatures and increased rainfall may alter the habitat for the Lakeside daisy in such a way that the plant cannot adapt or invasive plants may encroach (Union of Concerned Scientists 2009). It is not known how the Lakeside daisy will be impacted by temperature or precipitation increases, but lowered lake levels caused by increased temperature will further alter the climate (Easterling and Karl 2000). (USFWS, 2010)

Populations of Lakeside daisy cannot expand to unsuitable habitat, and some, particularly those associated with the Great Lakes, including the three sites at Kelleys Island, cannot migrate northwards due to the presence of the Great Lakes and/or development. Some subpopulations in Canada may be at risk from increased wave-wash and ice build up associated with increased storm intensity (COSEWIC, In Press, 2021). (USFWS, 2021)

**Stressor:** Herbivory (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Disease and predation were not listed as threats to the Lakeside daisy at the time of listing (53 FR 23742), though herbivory was included as an ecological threat to both natural and restored populations in the Recovery Plan (USFWS 1990). Predation, namely deer and rabbit herbivory, of this plant continues to pose a threat to Lakeside daisy, particularly small populations.

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5

**Delisting Criteria:**
1) 475 acres of essential habitat containing the population center at the Marblehead Quarry, Ottawa County, Ohio are acquired and managed. (USFWS, 1990)

2) 465 acres of additional essential habitat at the Marblehead Quarry is protected through easements, restrictive covenants or leases. (USFWS, 1990)

3) The variety is restored to a minimum of one large, stable population in each of two geographically distinct, protected sites of suitable size within the variety's historic range in Illinois. (USFWS, 1990)

4) Restored populations are maintained for fifteen consecutive years, with monitoring to continue for an additional ten years. (USFWS, 1990)

**Recovery Actions:**
- Provide adequate habitat protection for the only large, naturally-occurring population in the United States, i.e. Marblehead Peninsula, through the purchase or establishment of conservation easements of suitable modified alvar habitat from Lafarge. (USFWS, 2016)
- Coordinate monitoring among all three states where this species currently occurs so that information is consistent and meaningful. (USFWS, 2016)
- Provide necessary management at all protected sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ATV access, and reducing competition. (USFWS, 2016)
- Continue to augment introduced Lakeside daisy populations on suitable sites within the species' historical range. (USFWS, 2016)
- Revise recovery criteria to include new data prior to next 5-year review. (USFWS, 2016)

- Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. (USFWS, 2016)
- Cooperatively work with Lafarge Quarry to collect seed and transplant individuals from the areas of the quarry that are at greatest threat of being quarried and have the highest genetic and habitat diversity. (USFWS, 2016)
- Cooperatively work with the ODNR Division of Mineral Resources Management to amend the Lafarge Quarry mining permit so that undisturbed areas can be recolonized by Lakeside daisy, instead of being planted with other species and creating significant competition. (USFWS, 2016)
- Increase gene pools and population numbers in restored population sites by seeding and transplanting individuals from various locations within natural populations. (USFWS, 2016)
- Improve awareness to the public about the harm of collecting federally listed plant species and the importance of protecting and maintaining unique ecosystems, such as alvars, for recovery of plant species. (USFWS, 2016)
- Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat of Lakeside daisy introduction. (USFWS, 2016)
- Further research into the origin of the Michigan populations to guide future recovery actions. (USFWS, 2016)
- Revise recovery criteria to include new data prior to next 5-year review. (USFWS, 2010)
- Provide adequate habitat protection for the only large, naturally-occurring population in the United States, i.e. Marblehead Peninsula, through the purchase or establishment of conservation easements of abandoned quarry property. (USFWS, 2010)
- Cooperatively work with Lafarge Quarry to protect areas of the quarry that are least likely to be quarried and have the highest genetic and habitat diversity. (USFWS, 2010)
- Determine the presence or absence of seed banks and the duration of seed viability. (USFWS, 2010)
- Establish Lakeside daisy populations on suitable sites within the species historical range. (USFWS, 2010)
- Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat of Lakeside daisy introduction. (USFWS, 2010)
- Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. (USFWS, 2010)
- Increase gene pools and population numbers in restored population sites by seeding and transplanting individuals from various locations within natural populations. (USFWS, 2010)
- Provide necessary management at all protected sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ATV access and prescribed burning (in Illinois only). (USFWS, 2010)
- Conduct genetic research using highly polymorphic genetic loci to determine the genetic distance of natural populations and determine the viability of small, introduced populations. (USFWS, 2010)
- Inform the public about the harm of collecting federally listed plant species and the importance of unique ecosystems. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Future actions required to proceed with the recovery of this species focus on revision of current recovery criteria, population habitat management and protection, as well as research into the genetics of Lakeside daisy. These actions are listed below with highest priority actions listed first: • Provide adequate habitat protection for the only large, naturally occurring population in the United States, Marblehead Peninsula, through the purchase or establishment of conservation easements of suitable modified alvar habitat from LafargeHolcim. • Cooperatively work with LafargeHolcim to collect seed and transplant individuals from the areas of the quarry that have the greatest threat of being quarried and have the highest genetic and habitat diversity. • Conduct research into the genetics and diversity of the different populations to determine if seed from Ohio could increase the viability of the Michigan and Illinois populations. • Increase genetic diversity by continuing to augment introduced Lakeside daisy populations on suitable sites within the species' historical range with seeds and plants as feasible. • Provide necessary management at all sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ORV access, and reducing competition. • Coordinate monitoring among all three states and Ontario where this species currently occurs so that information is consistent and meaningful for comparisons. • Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. • Improve awareness to the public about the harm of collecting federally listed plant species and the importance of protecting and maintaining unique ecosystems, such as alvars, for recovery of plant species. • Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat to establish Lakeside daisy populations. • Consider revising recovery criteria to include new data prior to the next 5-year review. (USFWS, 2021).

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# SPECIES ACCOUNT: *Hymenoxys texana* (Texas prairie dawn-flower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/13/1986; Southwest Region (Region 2) (USFWS, 2016)

**Physical Description**

An annual plant 3.5—18 cm (1.4—7.1 in.) high with several divergent branches arising from a rosette of basal leaves. Basal leaves 1—16 mm (.04—59 in.) wide, up to 4 cm (1.6 in.) long, widest toward the tip, margins with short teeth or lobes from mid—blade to tip. Stem leaves few, linear. Flower heads usually few, small. Bracts of flower heads in two series 5—6 mm (.16—.20 in.) long. Ray flowers minute and concealed by the bracts. Disk flowers yellow, 3—4 mm (.12—.16 in.) long. Fruits about 2 mm (.08 in.) long with 5 apical scales 1—2 mm (.04—.08 in.) long (USFWS, 1989).

**Taxonomy**

Coulter and Rose (1891) described these plants as a new species and placed them in the genus Actinella. Greene (1898) separated the Actinella taxa with free phyllaries into the genus Tetraneuris and placed those with united outer phyllaries into the genus Picradenla. Thus, Hymenoxys texana became Picradenia texana (Coulter & Rose) Greene. Cockrell (1904) recognized Tetraneuris as a distinct genus but could not separate the North American Picradenia species from the genus Hymenoxys of South America. He, therefore, united Picradenia with Hymenoxys and transferred Hymenoxys texana into its present genus. The only specimens available to these early workers were the Thurow collections of 1889 and 1890. Hymenoxys texana was not collected again until 1981 when James Kessler discovered a few small populations north of Cypress in Harris County (Mahler 1982 and 1983). The relationship of Hymenoxys texana to four annual temperate South American species of Hymenoxys has yet to be thoroughly investigated. Three of these South American taxa lack ray flowers and perhaps one or more of them is the near relative of Hymenoxys texana, which has minute rays. A taxonomic treatment of the South American taxa is available (Parker 1962), and Sanderson (1973) reported the basic chromosome number of n = 15 for all four South American species. The North American Hymenoxys most similar to Hymenoxys texana is the annual species, Hymenoxys odorata, but the prominent long ray flowers and the deeply pinnately divided leaves of Hymenoxvs odorata easily distinguish it from Hymenoxys texana. (USFWS, 1989)

**Historical Range**

Up until about 1992, H. texana was known only from the northwest portion of Houston with only one population located in Fort Bend County (Barker Reservoir), with subsequent populations located in Addicks Reservoir in Harris County (USFWS, 2015).

**Current Range**

This species is now confirmed in five counties in Texas: Fort Bend, Gregg, Harris, Trinity, and Waller. (USFWS, 2015). A comparison of the current spatial distribution of the Texas prairie dawn flower with historical or previous reviews of this species shows the species has expanded its range westward into Waller County and beyond, and into northern regions of east Texas (USFWS, 2022).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 2015)

**Breeding Season**

Adult: March to April (USFWS, 2015)

**Other Reproductive Information**

Adult: Although a potential pollinator of the Texas prairie dawn-flower was identified as composite thrips Microcephalothrips abdominalis from specimens collected north of Cypress (Young 1987), new potential pollinators were identified and photographed during the 2022 flowering season. Harvester ants in the genus Pogonomyrmex, which builds characteristic mounds more than 50 cm in diameter in large cleared flat areas with small pebbles, were observed and recorded within many of the saline barrens supporting populations at the Warren Ranch and the Jack Roads Prairies managed by the Coastal Prairie Conservancy. The harvester ants observed on the Warren Prairies during the 2022 flowering season was identified as Pogonomyrmex barbatus (Dr. Ulrich Mueller at University of Texas, Personal mail communication dated July 21, 2022). Additional pollinators were also identified as miner bees in the genus Andrena on the Warren Prairie, and the green miner bee in the genus Lasioglosusm on the Gregg County private lands (Dr. Dan Bennett at Stephen F. Austin University, personal mail communication dated July 28 and 29, 2022, respectively). Future research conducted under the section 6 grant (WSFR Grant F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702) will also identify potential pollinators over the next two years (USFWS, 2022)

**Reproduction Narrative**

Adult: H. texana is an annual plant that flowers from early March through mid to late April and produces yellow, cone-shaped seed heads. (USFWS, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland/herbaceous, barrens, pimple mounds (USFWS, 2015; NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Found in poorly drained, sparsely vegetated areas (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Patches (USFWS, 2015)

**Environmental Specificity**

Adult: Moderate, with some key requirements (USFWS, 2015)

**Habitat Narrative**

Adult: H. texana is found in small, conspicuous, sparsely vegetated areas of fine, sandy, and compact soils. These bare spots are often located on the lower sloping portions of pimple mounds (USFWS 1990). Pimple mounds are low, roughly circular or elliptical domes or shield-like mounds, often with flat tops, composed of unstratified sandy loam soils coarser than, and distinct from, the surrounding less coarse, often clayey soil. Pimple mounds range from 1 to 30 m in diameter, and attain heights from about 10 cm to over 2 m (Johnson and Horwath Burnham 2012). H. texana thrives in disturbed, open areas with barren slicks made up of a select few soils, and where specific hydrological requirements can be met. Common soil series associated with H. texana consist of primarily Gessner Complex (Ge) and Katy Find Sandy Loam (Ka or Kf). Soils are slightly saline, sticky when wet and powdery when dry. Sometimes associated with other Texas Gulf Coastal Plain endemics such as Texas windmill-grass (Chloris texensis) and Houston machaeranthera (Machaeranthera aurea). A recent description of H. texana describes the species as found in localized patches ranging from 2 to 3 m in size or as large as 100 square meters usually associated with Gessner and Katy fine sandy loam soils which sometimes are located at the base of pimple mounds (Smeins 2014). (USFWS, 2015; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Not available.

**Number of Populations:**

~40 - 50 populations; exact number unclear (USFWS, 2015)

**Population Size:**

~50,000 in one location surveyed in 2012; population unknown at other sites (USFWS, 2015)

**Population Narrative:**

While there are 63 known occurrences of H. texana in the TxNDD (TPWD 2014) this can not be interpreted to mean that 63 distinct populations exist. Although nearly 50 populations are known for this species, almost all are threatened by development from the expanding city of Houston. Some sites have been destroyed within a year of their discovery. In 2012, a Gregg county landowner first identified H. texana on 187 ac (75.7 ha) where surveys found the largest H. texana population with estimates greater than 50,000 individuals. (USFWS, 2015)

***Threats and Stressors***

**Stressor:** Habitat loss and alteration (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Habitat conversion, fragmentation, and degradation continue to be a threat. Expanding urbanization, paved roadways, feral hogs, alteration of watershed drainages, development of natural resources, and agricultural development contribute to the continued loss of suitable habitat. Heavy grazing and in some cases illegal grazing practices can be detrimental to H. texana and may even prevent the species from recruiting. Although efforts to restore, create, and effectively manage habitat for the H. texana are currently underway, suitable habitat continues to be degraded or lost within this species range. Considerable increases in overstory vegetation are visible in aerial photography over a majority of the current species' range. This increase in canopy cover results in significant declines in some H. texana populations (e.g. Addicks and Barker Reservoirs) where thousands of individual plants once thrived at numerous sites. Due to limited habitat management at Addicks and Barker Reservoir, there is a significant decline in the number of suitable sites with H. texana present at this location and as a result, individual plant numbers have declined as well. Management practices such as mowing (with certain restrictions) do not seem to harm H. texana, and in some instances, promote its existence. However, deep soil disturbances such as plowing and feral hog wallowing can be detrimental to its existence. Many of the current sites are not adequately fenced and are subjected to feral hog and cattle grazing. Managed grazing and installing fence panels aimed at excluding feral hogs will greatly benefit H. texana (USFWS, 2015).

**Stressor:** Drought (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The distribution of H. texana appears to be naturally restricted as a result of the specific habitat and soil requirements. However, persistent drought conditions can cause the plant to remain dormant and produce smaller, less robust plants with fewer seed heads. The drought of 2011 was especially hard on H. texana as evidenced by the reduced number of mature plants. Cool and wet winter weather seems to be conducive to early spring growth and maturation. (USFWS, 2015)

**Stressor:** Competition (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from woody vegetation, such as Chinese tallow Triadica sebifera (an invasive exotic), yaupon Ilex vomitoria (native), and other native trees and grasses (at the ground and canopy layers), remains a large threat to the species. In areas where there is no on-the-ground management, the potential for loss is great as the woody vegetation continues to encroach creating a canopy cover that essentially allows other species to outcompete H. texana. The USFWS continues to work with other state and local partners to develop management guidelines to enhancing H. texana habitat. (USFWS, 2015)

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel

on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2012). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2012). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation). Winter and spring field observations indicate in years where drought conditions are prevalent, H. texana plants tend to respond with fewer, less robust individuals, and fewer seed heads. Conversely, in years where rainfall exceeds normal levels and plants may be inundated for extended periods of time, H. texana respond with fewer and less robust plants with yellowish leaves. Therefore, while it appears reasonable to assume that H. texana may be affected by the intense climate swings forecasted, and climate change should be considered a threat, the Service lacks sufficient certainty to know how climate change specifically will affect this plant. (USFWS, 2015)

***Recovery***

**Reclassification Criteria:**
Hymenoxys texana can be downlisted to threatened when: (USFWS, 1989).

(1) at least 50 separate populations, each occupying at least 1 hectare (2.47 acres) of suitable habitat, are discovered or established (USFWS, 1989)

(2) when at least 50 populations are protected from land use practices or land use changes that could destroy the populations (USFWS, 1989)

Recovery Priority Number: 2C.

**Delisting Criteria:**
Hymenoxys texana can be removed from the threatened and endangered species list when management practices are developed and implemented which ensure the numbers of plants at protected populations remain stable. (USFWS, 1989)

**Recovery Actions:**
- Protect Hymenoxys texana and its habitat from existing and future threats. Contact private landowners and Federal agency personnel. Work with the landowners and agency personnel to implement management practices that will protect the species. Establish protected sites on both private and public lands. Develop and implement a long range management plan. Enforce applicable Federal and State laws and regulations. Monitor populations. Alter management plans, if necessary, to reflect improvement or deterioration of populations (USFWS, 1989).
- Gather information on the natural history of Hymenoxys texana for use in management. Determine habitat requirements, including edaphic factors, dependence on natural phenomena and cultural practices, local microclimate, and air and water quality. Determine associated species, vegetation types, and community structure. Record associated

vegetation, frequency, density, and dominance. Determine frequently associated species. Determine If the bare soil at Hymenoxys texana sites represents an edaphic climax. Study population biology, including demography, phenology, reproductive biology (types of reproduction, pollination biology, seed dispersal and biology, seeding biology). Study community ecology, beneficial and neutral effects of other species, and negative effects of other species (USFWS, 1989).

- Update management plans as new data accumulates (USFWS, 1989).
- Search for new sites and populations (USFWS, 1989).
- Establish a botanical garden population and, if needed, attempt to establish populations In suitable natural habitat. Develop and refine propagation techniques. Establish a self—sustaining botanical garden population. Search for suitable reintroduction sites (USFWS, 1989).
- Develop public awareness, an appreciation, and support for the preservation and study of Hymenoxys texana (USFWS, 1989).
- The USFWS recommends the following actions be taken for the conservation of H. texana: - Reevaluate the 1990 Recovery Plan to reflect new species information including associated species lists, species range, survey methodologies, and soil findings in partnership with local land managers, botanists, and federal and state resource agency staff. - Develop protocol to delineate and define “populations” for downlisting or delisting this species. - Develop a central database to house all pertinent site population information. - Continue to monitor and survey known populations while searching for additional populations. - Update associated species list as necessary. - Implement section 6-funded projects, USFWS Partners for Fish and Wildlife program projects, and cooperative agreements with state and federal agencies. - Continue to search for additional populations. - Acquire new landowner conservation agreements with interested parties when appropriate. - Continue to support conservation and recovery awareness efforts through public and landowner outreach. - Redefine the range of H. texana through strategic GIS mapping efforts. H. texana is now more broadly distributed than originally thought, soil characteristics may be different at various locations, and associated species may vary at the different locations across the range. - Standardize surveying and monitoring protocols to provide consistent population data. If a new site is found, include soils analysis, associated species, genetic analysis, hydrological conditions, location, identify any threats, and note any pollinators present. - Yearly survey and monitoring data should be deposited with the TxNDD to facilitate accurate and up-to-date species specific information. (USFWS, 2015)
- Research Needs for the continued existence of H. texana - Assess and quantify predator threats (terrestrial mammals and/or insects). - Soil nalysis at each identified site. - Analyze and quantify the role of pollinators at H. texana sites. - Complete a thorough habitat range assessment using GIS analysis due to the increased range spanning five counties. - Conduct further research regarding alternative propagation techniques. - Complete additional studies to optimize frozen storage techniques for H. texana. - Identify propagation and relocation strategies for successful plug and seed transplant to suitable sites within the species range. - Identify the mechanism and/or agents of dispersal, dispersal patterns, and the effects of disturbance on dispersal. - Include genetic analysis for all sites to determine any genetic variability within sites. (USFWS, 2015)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that the following actions be taken for the conservation of the Texas prairie dawn flower (Hymenoxys texana): • Evaluate the recent SSURGO soil information on this species in conjunction with aerial imagery that identifies saline barren habitat on Gulf coastal prairies and Post Oak Savannah prairies that have not been previously surveyed, including the National Wildlife Refuges, where the Act does provide some legal protection for federally listed plants on federally owned lands. • Evaluate the genetics of at least 10 populations to determine if the species as a whole still possess levels of genetic diversity and heterozygosity that would be found among nonthreatened Hymenoxys species. • Continue to work with partners to annually monitor populations on their lands and use consistent standardized methods that were used during the 2022 field season that are comparable across all saline barren habitats. • Work with partners to acquire new habitat conservation plans for private landowners. • Investigate climate change effects on the reproductive and seed dispersal mechanisms of the species and its suitable habitat. • Evaluate and quantify predator effects (terrestrial mammals, invertebrates, and/or insects) on the species. • Evaluate and quantify the role of pollinators for this species • Work with partners to implement invasive species management plans and mowing strategies to restore suitable habitat for this species. • Work with partners to identify propagation and relocation strategies for successful plug and seed transplants to restore suitable habitat where invasive species management practices have been successfully implemented. Research conducted under the section 6 grant (WSFR Grant F22AP03103-00, BO Reference Ecosphere 2022-0024702) awarded to TPWD on July26, 2022, may provide new information on the reproductive biology, seed dispersal mechanism, genetics and pollinators for the Texas prairie dawn that will be available for the next 5-year review. We recommend once this information is reviewed, if possible given workloads, a Species Status Assessment could be conducted to guide the development of a revised recovery plan (USFWS, 2022).

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# SPECIES ACCOUNT: *Hypericum cumulicola* (Highlands scrub hypericum)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/20/1987; Southeast Region (R4)

**Physical Description**

Hypericum cumulicola is a small, short-lived perennial herb reaching 20 to 70 cm in height. It is branched from the base and has a woody, fibrous root system. The stems are shorter and more numerous in winter and spring before reproductive stalks are differentiated. Usually there are three stems, but there can be as many as 17 stems on a healthy plant (Quintana-Ascencio and Morales-Hernández in press). During the reproductive season, all stems of mature individuals bear flowers and fruits. The leaves of H. cumulicola are opposite, simple, entire, and needle-like. Flowers are small, bisexual, and arranged in cymes. The calyx consists of five distinct sepals, while the corolla consists of five bright yellow petals shaped like the blades of a propeller. There are approximately 27 anthers. The gynoecium has three, sometimes four locules, and the ovary is superior with approximately 22 ovules aligned around the walls of the ovary (parietally). The style has three, sometimes four, white lobes. Fruits are small capsules, red when immature and dark purple at the time of dehiscence. Mature seeds are small and dark brown. This species, as other Hypericum, may contain hypericin, a promising compound with protective effect in the control of viral diseases in animals (Duke 1989) (USFWS, 1999)

**Taxonomy**

Hypericum is a predominantly temperate genus, and a member of the family Hypericaceae. This family is closely related to the Clusiaceae (Guttiferae), and some authorities include both groups together (Cronquist 1988). In central Florida, H. cumulicola is morphologically distinct from other species in its genus (Ward and Godfrey 1978). In 1924, Small first named the plant Sanidophyllum cumulicola. Later, Adams (1962) reassigned the species to the genus Hypericum, renaming it Hypericum cumulicola. Hypericum cumulicola's closest relative in Florida is H. gentianoides, which is very similar morphologically, but branches repeatedly above the base versus only at the base for H. cumulicola (Archbold Biological Station, personal communication 1998). (USFWS, 1999)

**Historical Range**

See current range.

**Current Range**

Lake Wales Ridge in Polk and Highlands counties in Florida, from just north of Sunray, Polk County (FWS 1996) to the south end of the Lake Wales Ridge near Archbold Biological Station in Highlands County. (USFWS, 1999)

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Because Highlands scrub hypericum has many-flowered stems, a single large plant can have as many as 1,600 reproductive structures (fruits, flowers, or buds) by the end of the reproductive season (Quintana-Ascencio and Morales Hernández 1997). Flowers are exposed one at a time or in small numbers (up to eight per branch) each day. The new flowers open early in the morning and the petals curl up by noon depending on the weather. This species is self-compatible, but the flowers must be visited by pollinators to set seed (ABS 2003). The mature purple capsules remain attached to the stem after releasing seeds. Seeds do not show any obvious primary dispersal mechanism and probably are dispersed passively by gravity. "Native solitary bees (Dialictus spp. and Augochloropsis spp.) appear to be the primary pollinators. Other visitors include Geron sp., Copestilium nigrum, and Bombus sp. Pollinator visitation occurs at similar rates regardless of flower or plant density" (ABS 2003, citing Boyle and Menges 2001; M. Evans, personal communication in Quintana-Ascencio et al. 1998). Most flowering and fruiting occurs between June and September, coinciding with the rainy season and daily thunderstorms typical of the region. Stems dry at the end of the reproductive season and new ones sprout from the base in late winter and early spring. Germination occurs from November through June, but most seedlings germinate between December and February. Plants reach maturity in as little as a year. Highlands scrub hypericum inhabits Florida scrub vegetation on upland areas with excessively drained white sand soil (Judd 1980a). It is almost exclusively found in rosemary balds – patches of bare sand surrounding Florida rosemary within scrub vegetation. It shares these bare patches with a number of other small scrub endemic herbs, grasses, and even a few small shrubs (Christman and Judd 1990). Rosemary balds have a fire frequency from 10 to 100 years (Myers 1990) while the surrounding scrubs have higher fire return intervals. Occasionally, Highlands scrub hypericum occurs in openings in well-drained scrubby flatwoods or with turkey oak on yellow sand soil (P. Quintana-Ascencio, ABS, personal communication, 1995). Where found, it is locally common and can occur in large groups of several thousand individuals (Judd 1980a).

**Habitat Type**

Adult: Scrub

**Environmental Specificity**

Adult: Very Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Highlands scrub hypericum is one of a suite of herbs (and a few grasses) that inhabit sunny, sandy gaps between the shrubs that dominate scrub vegetation. Many of these gap-inhabiting species are endemic to the LWR. The gap size requirements of Highlands scrub hypericum appear to be intermediate between those of two other co-occurring rosemary scrub plants: snakeroot, which is restricted to large openings (Menges and Kimmich 1996); and wireweed, which is found in large and small gaps between shrubs (Hawkes and Menges 1995). Highlands scrub populations have a high degree of genetic differentiation among populations (Menges et al. 2001).

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

34 (USFWS, 2021)

**Population Narrative:**

Most populations of Highlands scrub hypericum are relatively small. The median size for 34 populations was 539 individuals, and most populations were smaller than 1,000 plants (Menges et al. 1998). A population viability model (Quintana-Ascencio et al. 2003) concluded that “fire kills above-ground individuals, but seeds in the soil survive fire and form long-lived seed banks. Fire suppression and alteration of fire regimes constitute a threat for this species because of its dependence on fire to release local populations from competitive exclusion” (ABS 2003). “After fire in Florida rosemary scrub, Hypericum cumulicola [Highlands scrub hypericum] had higher fecundity, survival, establishment, and population growth rates than in unburned populations” (Quintana-Ascencio et al. 2003). This may be due to a number of mechanisms, including killing back of shrubs, removal of lichens, destruction of allelopathic agents that affect seed germination, and the creation of open gaps that may have higher levels of soil water (Quintana-Ascencio et al. 2003). The seed germination rate for this species is extremely low except at recently-burned sites (Quintana-Ascencio et al. 2003). The most critical life-history stage influencing Highlands scrub hypericum’s population growth rate and fitness is seed survival in the soil seed bank. The next-most-important life-history stage is seedling recruitment (Quintana-Ascencio et al. 2003). Massive recruitment of plants in favorable patches and in favorable years allows Highlands scrub hypericum populations to “increase rapidly and/or replenish the soil seed bank. Similar population explosions are documented in other short-lived perennials (Picó et al. 2002) and annual plants with a seed bank (Kalisz and McPeek 1992), which are able to cope with high or unpredictable environmental variation” (Quintana-Ascencio et al. 2003). The survival of Highlands scrub hypericum populations in fire-dependent habitats thus depends on the seed bank, while seedling recruitment is highly variable and depends on environmental cues (Picó et al. 2003). A population viability assessment model (Quintana-Ascencio et al. 2003) strongly also affirms that fire is essential for Highlands scrub hypericum to persist over the long term. Even the largest populations may be imperiled by fire intervals greater than 50 years. Smaller populations are more vulnerable to lack of fire. These authors consider fire suppression and alteration of fire regimes to constitute threats to this species “because of its dependence on fire to release local populations from competitive exclusion” (Quintana-Ascencio et al. 2003; Quintana-Ascencio and Morales Hernández 1997; Quintana-Ascencio and Menges 2000). In planning fire regimes for scrub, it is important to take into consideration the needs of multiple plant and animal species. Management that alternates short and long fire intervals may allow species to coexist, while invariant fire return intervals may harm some species (Quintana-Ascencio et al. 2003). Researchers at ABS have developed spatially explicit disturbance-demographic models of Highlands scrub hypericum. “This spatially explicit, individual-based model improves the precision of prior matrix projections that did not include Florida rosemary or spatial structure. It allows prediction of ranges of Florida rosemary densities that will allow scrub hypericum populations to persist under various fire regimes.” The model’s predictions agreed with “observed differences in scrub hypericum disappearance among gaps with contrasting rosemary densities but similar times-since-fire,” so this modeling approach is likely to prove useful in predicting the effects of fires and other disturbances, including mechanical treatments of overgrown scrub, such as roller-chopping (Quintana-Ascencio et al. 2004). Early inventories of LWR endemic plants found this species at few sites – only 69 of 254 scrub sites surveyed by Christman (1988) (ABS 2003). This severely restricted range, combined with continuing habitat loss, led to its listing. Highlands scrub hypericum is locally abundant, with populations larger than a thousand plants and presumably large seed banks in the soil at ABS, the properties of the LWRWEA (including Lake Placid, Holmes Avenue, Lake Apthorpe, and Carter Creek), Lake June-in-Winter Scrub State Park, TNC's Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWR State Forest. On these lands, Highlands scrub hypericum has benefited from fire-oriented land management practices and insights provided by the intensive demographic research program at ABS. Highlands scrub hypericum is protected on 22 sites, often with large population sizes and active fire management. However, remaining unprotected populations are in imminent danger of decline and extirpation. Unprotected habitat continues to be developed for agriculture, housing, and other uses. This is likely reducing the number and size of populations of this species. The most recent estimate of the loss of xeric upland habitat on the LWR is 87 percent (Turner et al. 2006). On managed areas that include the protected occurrences, better land management is needed to ensure that protected populations remain extant. Appropriate management includes avoiding fire suppression, avoiding fires before forecasted droughts, creation of gaps, and avoiding damage by vehicles or pedestrian trampling to plants and to the cryptobiotic soil crust, which may facilitate seedling emergence. Inappropriate fire regimes remain a significant threat. Most scrub sites supporting Highlands scrub hypericum are not burned frequently enough to support viable populations and mechanical pre-treatments or surrogates may not provide the same benefits as fire. Exotic species invasion and herbivory are potential threats but have not been directly implicated as causing population declines. Few, small, isolated populations in a limited geographic range present additional risk for Highlands scrub hypericum. These factors, in conjunction with the species' limited dispersal potential, hinder population resiliency and ultimately recovery. Anticipated climate change factors such as alterations to temperature and precipitation patterns, tropical storm intensity, and sea-level risk will only exacerbate these threats. Due to these ongoing threats mentioned above, this species continues to meet the definition of endangered under the ESA. (USFWS, 2021). Highlands scrub hypericum is locally abundant at ABS, the properties of the LWRWEA (including Lake Placid, Holmes Avenue, Lake Apthorpe, Gould Road, and Carter Creek), Lake June in Winter Scrub State Park, The Nature Conservancy's (TNCs) Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWRSF. Many other populations of Highlands scrub hypericum are relatively small. Population size estimates for 34 populations showed a median of 539 individuals, most populations were smaller than 1,000 plants, the largest population was estimated to be greater than 300,000 plants, and the 25th -75th percentiles for population size were 130-4,000 plants (data summarized in Table 1 of Menges et al. 2001). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further

loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of H. cumulicola are adequately protected from further habitat loss, degradation, fragmentation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of sandpine scrub to support H. cumulicola (USFWS, 1999)

4. When monitoring programs demonstrate that populations of H. cumulicola on these sites support sufficient population sizes (USFWS, 1999)

5. When those populations are stable and distributed throughout the historic range (USFWS, 1999)

6. When H. cumulicola are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

**Delisting Criteria:**
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution of H. cumulicola. This species has been relatively well-surveyed and a distribution has been ascertained. Additional surveys will confirm the species' distribution and locate new sites. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of H. cumulicola. Continue the study of basic biology and ecology of this species. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of H. cumulicola. (USFWS, 1999)
- Provide public information about H. cumulicola. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where H. cumulicola is

found. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Develop land management plans that address the following threats to Highlands scrub hypericum: avoiding fire suppression, avoiding fires occurring before forecast droughts, creation of gaps, avoiding disturbances from off-road vehicles, and avoid trampling of Highlands scrub hypericum and the cryptobiotic soil crust that may facilitate its seedling emergence. • Collect data on the response of Highlands scrub hypericum to management activities such as roller chopping, mowing, gyro-tracking, logging, and chain-saw felling and, to the extent that responses are dissimilar to post-fire responses, adjust fire-based population viability models. • Develop a metapopulation model using information on population dynamics within populations, the number and distribution of populations, and dispersal among populations (for plants, mainly seed dispersal) to determine the number of self-sustaining populations needed to ensure persistence. • Study seed dispersal among populations of Highlands scrub hypericum for use in a metapopulation model. • Conduct quantitative level 2 surveys (counting individuals in defined areas) at additional sites outside of ABS and the LWRSF. Surveys should track changes in population sizes over time and in response to management treatments. • Land purchase or conservation easement of key parcels (e.g., Hendrie Ranch, Lizzie Lakes) to protect important populations. • Surveys for Highlands scrub hypericum at privately-owned, unprotected sites. • Targeted collection of Highlands scrub hypericum from unprotected sites for ex situ conservation. Highlands scrub hypericum currently has limited protection in Bok Tower Garden’s ex situ collection, with 32,012 seeds collected from 1988-1990 in cryogenic storage, and two plants from one population in their living collection (P. Gonsiska, Bok Tower Gardens, pers. comm. 2020). (USFWS, 2021)

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# SPECIES ACCOUNT: *Iliamna corei* (Peter's Mountain mallow)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 05/12/1986; Northeast Region (R5) (USFWS, 2015)

**Physical Description**

Iliamna corei is an erect, ascending, perennial herb growing from a woody rhizome producing densely pubescent pale-green branches up to 1 m in height. The maple-like leaves are simple, with 5-7 palmate lobes, margins serrate to dentate, bases truncate to cordate, and stellate-pubescent on both surfaces. The size of the leaves decreases gradually towards the tips of the branches. The pink flowers are solitary or clustered in the axils of the upper leaves. There are 5 radially symmetrical, separate petals 2.5-3 cm long and 5 sepals fused 1/4 to 1/2 their length into a bell-shaped, hairy calyx. Stamens are numerous, their bases fused into a tube surrounding the pistil. The flower appears generally similar to the cultivated hibiscus, or rose-of-Sharon. Fruits are lobed capsules with mature carpels 8-10 mm long, densely hairy, containing 2-3 seeds in each carpel. (USFWS, 1990)

**Taxonomy**

Considered a distinct species known only from a single site in the Virginia mountains. Bodo Slotta & Porter (2006) studied the genetic variation in North American Iliamna and analyses determined that I. corei is distinct. Additional research in the late 1980s also support that this taxon should be separated from I. remota on the basis of genetic analyses. Kartesz considers these differences minor, and includes these Virginia plants, along with Iliamna remota, in his circumscription of the nominate variety of Iliamna rivularis. Included in Iliamna rivularis var. rivularis by Kartesz, 1994 checklist and 1999 floristic synthesis; by others considered distinct from I. rivularis, but included in Iliamna remota. (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Only site known is Giles County in Ridge and Valley Province of Virginia. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (vegetative) and sexual (outcrossing) (NatureServe, 2015)

**Dependency on Other Individuals or Species**

Adult: Pollinated by bees (USFWS, 1990)

**Breeding Season**

Adult: Late June to early August (USFWS, 1990)

**Key Resources Needed for Breeding**

Adult: Seed scarification is required for germination (Bodo Slotta & Porter 2006) (NatureServe, 2015)

**Reproduction Narrative**

Adult: Iliamna is rhizomatous. Seed scarification is required for germination (Bodo Slotta & Porter 2006). I. corei flowers from late June to early August. It is believed to be pollinated primarily by sweat bees of the genus Halictus, which are abundant in the area. (USFWS, 1990; NatureServe, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest - Mixed, Forest/Woodland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Sunny, open areas (USFWS, 1990)

**Geographic or Habitat Restraints or Barriers**

Adult: Mature Iliamna corei plants appear to prefer open sites without much competing vegetation (USFWS, 1990)

**Environmental Specificity**

Adult: Very Narrow (inferred from USFWS, 1990; NatureServe, 2015)

**Dependency on Other Individuals or Species for Habitat**

Adult: The dominant trees growing in association with I. corei include Quercus rubra, Q. prinus, Carya spp., Robinia pseudo-acacia, Pinus virginiana, Betula lenta, and Celtis occidentalis. The shrub layer is primarily composed of Berberis canadensis, Crategus spp., and Rhus typhina. The more common herbs, forbs, and vines include Verbesina occidentalis, Tradescantia ohiensis, Polymnia canadensis, Aquilegia canadensis, Chenopodium standleyanum, Rosa carolina, Dioscorea villosa, Clematis viorna, and Parthenocissus guinquefolius. The only plants that appear to be directly competing with the Iliamna are Polymnia and Berberis. (USFWS, 1990)

**Habitat Narrative**

Adult: Iliamna corei occurs in the shallow soil of the Clinch sandstone outcrops on the northwest-facing slope of Peters Mountain (elevation 1000 m), near the ridge line of a mixed deciduous-evergreen forest. Regarding the species' edaphic requirements, soil tests from the sites of two different Iliamna clones show pH ranging from 5.3 to 5.6. Quantities of macro-and micronutrients from the two sites (in parts per million) include: phosphorus (32 and 53), potassium (157 and 58), calcium (120), and magnesium (101 and 65). Soils underlying the Iliamna population are very dark and appear to be highly organic in composition. The dominant trees growing in association with I. corei include Quercus rubra, Q. prinus, Carya spp., Robinia pseudo-acacia, Pinus virginiana, Betula lenta, and Celtis occidentalis. The shrub layer is primarily composed of Berberis canadensis, Crategus spp., and Rhus typhina. The more common herbs, forbs, and vines include Verbesina occidentalis, Tradescantia ohiensis, Polymnia canadensis, Aquilegia canadensis, Chenopodium standleyanum, Rosa carolina, Dioscorea villosa, Clematis viorna, and Parthenocissus guinquefolius. The only plants that appear to be directly competing with the Iliamna are Polymnia and Berberis. (USFWS, 1990)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2008)

**Species Trends:**

Declining (USFWS, 2008)

**Number of Populations:**

1 (NatureServe, 2015)

**Population Size:**

1 - 250 individuals (NatureServe, 2015)

**Additional Population-level Information:**

Monitoring reports from The Nature Conservancy indicated that since the 2008 status review, the Peter’s Mountain Mallow numbers have fluctuated, but the overall population trend appears to be stable (USFWS 2019).

**Population Narrative:**

Peters Mountain mallow (Iliamna corei), a member of the family Malvaceae, is known from only a single site on Peters Mountain, near The Narrows of the New River, in Giles County, Virginia. The occurrence is very tolerant to on-site activities. (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Encroachment of vegetation (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The encroachment of competing vegetation, resulting in a reduction of direct sunlight reaching the plants, appears to be contributing to the decline in the size and reproductive vigor of the population. Historical references indicate that Iliamna corei was previously exposed to a great deal more direct sunlight than is the case today (U.S. Fish and Wildlife Service, 1986). In recent years forest canopy on Peters Mountain has grown considerably, probably in association with fire suppression management. Construction of a hiking trail and a powerline near the mallow site in the early 1970s appears to have promoted the invasion of weedy competitors, primarily Polymnia canadensis. (USFWS, 1990)

**Stressor:** Lack of recruitment (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A major concern in regard to recovery of Iliamna corei has been lack of recruitment. Although a viable seedbank exists in the soil, no seedlings are being produced because the seeds are not germinating. Recent experimental evidence indicates that germination is readily stimulated by heat (Baskin and Baskin, 1990) and light fire (C. Baskin and J. Baskin, pers. comm.). (USFWS, 1990)

**Stressor:** Low sexual fecundity (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In addition to the lack of seed germination at the natural population site, the remaining I. corei clones have been exhibiting extremely low sexual fecundity. From 1986-1988, only 14 mature capsules were produced, despite profuse flowering. Many buds aborted before flowering, and the majority of buds that did produce flowers disarticulated from the plant after anthesis. The record drought years of 1987 and 1988 may have contributed to reproductive failure; however, the plants were watered regularly during the drought periods of those years. Seed production data from most of the years previous to 1986 are unavailable, but Strausbaugh and Core indicated that, in 1932, the plants were producing an "abundant supply of seeds." Herbarium specimens collected by Massey in 1934 and 1939 (at VPI&SU) also have mature capsules containing many seeds (J. Randall, pers. comm.). The mystery of seed production in the natural population has been largely solved and the problem ameliorated by recent work at VPI&SU, as described below. (USFWS, 1990)

**Stressor:** Small population size (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because so few plants comprise the natural population, removal of individual stems, whether by humans or other animals, constitutes a threat to the species' survival. In October 1987, a feral goat browsed all of the Iliamna stems to within 30 cm of the ground. In 1987 and 1988, a total of 16 stems were cut, apparently for collection. (USFWS, 1990)

**Stressor:** Herbivory (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory by deer and other animals is a continuing threat, mitigated by placement of small wire cages around individual and small groups of PMM. Replacement and enlargement of these enclosures to accommodate plant growth requires continuing annual effort throughout the field season (Edward and SanJule 2007). (USFWS, 2008)

**Stressor:** Fire suppression (USFWS, 2008)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Suppression of natural fires necessitates an on-going commitment to prescribed burning. (USFWS, 2008)

***Recovery***

**Reclassification Criteria:**
1. The natural population has reached carrying capacity and has been self-maintaining or expanding into new areas for at least 5 years. (USFWS, 1990)

2. Life history, ecology, and population biology are understood sufficiently to manage effectively. (USFWS, 1990)

3. There exists an established and continuing management program. (USFWS, 1990)

4. The tract of land on which it occurs is permanently protected. (USFWS, 1990)

5. Plants representing a variety of genotypes are propagated at a minimum of two plant breeding facilities. (USFWS, 1990)

Recovery Priority Number: 8

**Delisting Criteria:**
1. The natural population has reached carrying capacity and has been self-maintaining or expanding into new areas for at least 5 years. (USFWS, 1990)

2. Life history, ecology, and population biology are understood sufficiently to manage effectively. (USFWS, 1990)

3. There exists an established and continuing management program. (USFWS, 1990)

4. The tract of land on which it occurs is permanently protected. (USFWS, 1990)

5. Plants representing a variety of genotypes are propagated at a minimum of two plant breeding facilities. (USFWS, 1990)

6. Studies indicate that it is appropriate to establish new populations. (USFWS, 1990)

7. Five additional populations have been located or established. (USFWS, 1990)

8. These new populations are protected and stable or expanding for at least 5 years. (USFWS, 1990)

**Recovery Actions:**
- Monitor known population and manage as necessary. (USFWS, 1990)
- Study life history, ecological, and population parameters. (USFWS, 1990)
- Maintain representative individuals at two plant breeding facilities. (USFWS, 1990)

- Outplant individuals within historic range. (USFWS, 1990)
- Acquire full title to the population site. (USFWS, 1990)
- Research to better understand site requirements and germination and care for seedlings so new populations can be established (USFWS 2019).
- Research the seasonality and intensity of fire needed to stimulate germination of seeds in the seed bank. This would help to better manage existing population and plan burns in new areas (USFWS 2019).
- Conduct and assess effects of landscape burn in 2009. Burn implementation is already scheduled and funded. (USFWS, 2008)
- Continue ex situ seed increase efforts and assure long-term seed storage. (USFWS, 2008)
- Update reclassification criteria 1 and 5 to clarify target population size and composition (whole plants and seed production) in the wild and requirements for ex situ conservation. Updated criteria, consistent with the scope and intent of the corresponding criteria in the 1990 recovery plan, should reflect current information about PMM biology. (USFWS, 2008)
- Based on results of initial landscape scale burn, evaluate future burning requirements and associated funding needs. (USFWS, 2008)
- Develop long-term agreements for continuing management of PMM population(s) at the Narrows Preserve. (USFWS, 2008)
- Reconsider need for and desirability of establishing additional PMM populations outside the species' known historic range. Evaluate feasibility of alternative strategies to provide for long-tern security and delisting of PMM. If necessary, revise delisting criteria and recovery plan accordingly. (USFWS, 2008)

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# SPECIES ACCOUNT: *Ivesia kingii var. eremica* (Ash Meadows ivesia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 05/20/1985; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A perennial herb that forms a tuft of narrowly divided, grayish leaves. Flowering stems are about 9 cm long and bear white flowers from August to October. Some botanists question whether this taxon is distinctive enough to be maintained as a discrete variety of the species I. kingii. (The species as a whole is extremely variable and somewhat rare.) (NatureServe, 2015).

**Taxonomy**

A member of the Rosaceae family (USFWS, 1990). Kartesz (1994 checklist and 1999 floristic synthesis) does not recognize varieties in this species; however, USFWS recognizes var. eremica as distinct from the typical var. kingii. As Kartesz notes (in letter to Larry Morse, 25Nov99), he reviewed all of the available Nevada collections and concluded that "this [var. eremica] is nothing more than an extremely variable expression of Ivesia kingii"; he also notes that various individuals, including Barbara Ertter, had listed characters considered useful in separating the two taxa, she (Ertter) has more recently indicated (in a personal communication with Kartesz) that researchers in the Netherlands "also maintain it as nothing more than a taxonomic synonym of Ivesia kingii." However, Ertter (in a personal communication to Jim Morefield) as of 06 Apr 99 still considered this a valid taxon at the varietal level (NatureServe, 2015).

**Historical Range**

Endemic of Ash Meadows, south Nye County, Nevada. Type found in Coville and Funston, Nye County, Nevada in 1891 (NatureServe, 2015).

**Current Range**

Small, local populations are scattered throughout Ash Meadows in Nevada (USFWS, 1990).

**Critical Habitat Designated**

Yes; 5/20/1985.

**Legal Description**

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Ivesia kingii var. eremica (Ash Meadows ivesia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

**Critical Habitat Designation**

The critical habitat designation for Ivesia kingii var. eremica includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Ivesia kingii var. eremica critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include saline seep areas of light colored clay uplands.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**
Adult: Sexual (inferred from sews, 1990)

**Lifespan**
Adult: 2+ years (inferred from USFWS, 1990)

**Breeding Season**
Adult: Summer - fall (USFWS, 1990)

**Reproduction Narrative**
Adult: Plants are perennial. It produces flowers during the late summer and autumn (Mozingo and Williams 1980) (USFWS, 1990).

**Habitat Type**
Adult: Wetland, terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**
Adult: Saltbrush scrub near springs (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**
Adult: 657 - 690 m elevation (NatureServe, 2015)

**Spatial Arrangements of the Population**
Adult: Solitary clumps (USFWS, 1990)

**Environmental Specificity**
Adult: Very narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**
Adult: Low (inferred from NatureServe, 2015)

**Habitat Narrative**
Adult: Inhabits moist alkaline areas in openings of saltbrush scrub near springs. It is dependent on springs. Dust from erosion may smother plants. Found at elevations of 657 - 690 m. It is narrowly confined to a single spring-fed desert wetland area with extremely saline soils (NatureServe, 2015). It occupies highly alkaline, barren soils that remain moistened by water spreading outward from surface flow discharged by springs. Plants occur as solitary clumps (USFWS, 1990).

### *Dispersal/Migration*

**Dispersal/Migration Narrative**

Adult: Not available

### *Population Information and Trends*

**Population Trends:**

Not available

**Number of Populations:**

8-9 (USFWS, 2020)

**Population Size:**

510,744 (USFWS, 2020)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

In 1987, Ash Meadows ivesia was known from seven populations within the Ash Meadows area (Knight and Clemmer 1987, pp. 73–74). In 1998, Knight and Clemmer's populations were re-surveyed and re-confirmed, and an additional population of Ash Meadows ivesia at Jackrabbit Spring was discovered (Service, unpubl. survey, 1998). In 2001, Ash Meadows ivesia was estimated to occur across 9 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 8 maximum scale occurrences (0.6 mi (1 km) separation distance) on approximately 9.1 ac (3.7 ha) (Morefield 2001, p. 1). Refuge-wide surveys at the Ash Meadows National Wildlife Refuge (Refuge) of listed and rare plants, including Ash Meadows ivesia, were initiated in 2008 and completed in 2010 (BIO-WEST 2011, entire). As a result of these surveys, 9,000 ac (3,642 ha) were surveyed and the approximate Refuge area covered by Ash Meadows ivesia is 116.1 ac (47 ha) (BIO-WEST 2011, pp. 121– 123). On these 116.1 ac (47 ha), 19 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 2 maximum scale occurrences (0.6 mi (1 km) separation distance) were reported (BIO-WEST 2011, pp. 121–123). Distribution of Ash Meadows ivesia is depicted in Figure 1. At the time of listing, a population estimate of Ash Meadows ivesia was unknown (Service 1985, p. 20777). In 2001, the Ash Meadows ivesia population on the Refuge was estimated to be approximately 3,862 individuals (Morefield 2001, p. 1). Results from the 2008–2010 Refugewide rare plant survey produced an estimate that 510,744 individuals are present on the Refuge (Table 1; BIO-WEST 2011, pp. 121–123). This estimate remains the best available for the Refuge population. Estimates of Ash Meadows ivesia individuals on the BLM ACEC and private lands within the Refuge boundary do not exist. (USFWS, 2020)

### *Threats and Stressors*

**Stressor:** Past habitat destruction and modification (USFWS, 1985)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** The presence of water in Ash Meadows has long attracted human activity and provided a refuge for man's survival in an arid desert. The magnitude of man's impact on the local environment has increased over time and resulted in the decline of local endemic species Large-scale disturbance began in the early 1960's when approximately 2,000 acres of upper Carson Slough was mined for peat. This removed approximately six feet of substrate and eliminated on of the largest marshes in southern Nevada. Endemic plant populations were reduced or eliminated when lands were cleared for crops and pasture, roads were constructed, and when impoundments were constructed then filled (Sanchez 1981). Impoundments now inundate several hundred acres of habitats believed to support the Ash Meadows ivesia. Many roads were built through areas now designated as critical habitat for plant species. Approximately 65 miles of gravel and unimproved roads now exist within the essential habitat, directly affecting Ash Meadows ivesia. All of the endemic species were additionally affected by secondary impacts of these roads, which largely resulted from increased vehicular access to sensitive areas. Because of all past activities, small populations of species endemic to Ash Meadows presently occupy a small portion of their historic habitat (USFWS, 1990).

**Stressor:** Introduced species (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Introduced species, including salt cedar (Tamarix), mosquitofish, sailfin mollies (Poecelia lativinna), wild horses, bullfrogs, and crayfish further reduced endemic plant and animal populations by displacement through competition for food and space, and/or predation (Miller 1948, Beatley 1977 a, b; Reveal 1978 a, b, c; Soltz and Naiman 1978, Schoenherr 1981, Knight and Clemmer 1987). Roads facilitated introduction of non-native species (particularly aquatic species), and the detrimental influence of trampling caused by water-oriented recreation. Introduced species are now widespread throughout the area, and trampling has reduced populations of endemic mollusks and plant populations adjacent to springs. Large herds of wild horses altered spring morphology and impacted endemic plant and snail populations (Hershler and Sada 1987, Landye 1973, Mozingo and Williams 1980) (USFWS, 1990).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 8

**Delisting Criteria:**
1. The species is present in all locales it historically occupied within Ash Meadows (USFWS, 1990).

2. The species has reached self-sustaining populations (as measured by frequency values for plants on critical habitat) (USFWS, 1990).

3. The essential habitat is free of threats from all non-native animals, exotic plants, and detrimental human disturbances (USFWS, 1990).

4. Springs have returned to historic discharge rates and water flow is reestablished into historic channels (USFWS, 1990).

5. Native plant and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 1990).

**Recovery Actions:**

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new and existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).
- Approval of the Ash Meadows Habitat Management Plan by the Bureau initiated a number of more recent conservation programs on public domain lands (USBLM 1980). Barbed wire fencing was installed to prevent wild horses' entrance to approximately 425 acres surrounding Big and Jackrabbit Spring s, and emergent vegetation has been periodically removed from School Springs. Wild horses were captured during August 1985 to eliminate trampling of springs, stream banks, and rare plants (USFWS, 1990).
- The States of Nevada and California and the Service have been actively involved in recognizing the declining status of species endemic to Ash Meadows. These agencies variously list a number of local species as either threatened or endangered. Numerous botanists affiliated with various universities and native plant societies throughout the nation have surveyed the area's vegetation and documented rare plant distribution. Although much work has been conducted, much of it has been directed toward preventing further loss of populations and habitat and not toward habitat or population enhancement. The purchase of much of the area by The Nature Conservancy and subsequent purchase of these lands by the Service to establish the Ash Meadows Refuge has been the single largest step toward providing security for these species (USFWS, 1990).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); and III. Support Ash Meadows ivesia research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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# SPECIES ACCOUNT: *Jacquemontia reclinata* (Beach jacquemontia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Beach jacquemontia is a perennial vine which has a main stem with numerous laterals spreading out from a stout rootstock (Robertson, 1971). These reclining, partly twining or ascending, slender stems are woody at the base and may twine over other plants (Robertson, 1971; Austin, 1979). The older leaves and stems of this species can be glabrous, but the pubescence makes younger leaves and stems appear whitish (Austin, 1979). The leaves are entire, alternate, estipulate, spirally arranged, and almost always petiolate, reaching one to three cm in length and 0.5 to 2.5 cm in breadth (Small, 1905; Robertson, 1971; Austin, 1979). The flowers of this species are white to light pink and the sepals are persistent. The inflorescences can be axillary cymose or solitary with branches 8-40 millimeters (mm) long, usually not exceeding the leaves (Robertson, 1971; Austin, 1979). The fruit is a light brown capsule about four to five mm long (Small, 1905; Robertson, 1971). Additional physical descriptions of beach jacquemontia can be found in Small (1905) and Robertson (1971).

**Taxonomy**

Though J. havanensis is closely related, beach jacquemontia's main distinction is its ciliolate (marginal fringe of hairs) sepals and rather succulent leaves (Robertson, 1971). This ciliolate on the outer sepals and fleshy leaves also distinguishes this species from J. curtissii, which has hairless sepals and narrow leaves that are not fleshy (Austin, 1979). There are about 100 species of the genus Jacquemontia, most of which are found in tropical and subtropical America (Robertson, 1971). Beach jacquemontia is the only species found along the beaches of southeastern Florida (Austin, 1979). Beach jacquemontia was first described from specimens collected in 1903 at northern Miami Beach (Small, 1905). The original treatment of this taxon as a distinct species was upheld by Robertson (1971) during a review of the genus Jacquemontia. Three other species are found in Florida: J. curtissii inhabits pinelands on the mainland, while J. jamaicensis and J. pentantha occur in the Florida Keys (Small, 1933). Although Small (1933) considered beach jacquemontia's range to extend into the West Indies, Austin (1979) considered it endemic to the east coast of Florida.

**Historical Range**

Found historically in Martin Co. FL (NatureServe, 2015)

**Current Range**

Palm Beach, Broward, and Dade Cos., FL; reintroduction projects initiated. (NatureServe, 2015). Beach jacquemontia is a member of the morning glory family (Convolvulaceae) that is restricted to the southeastern coast of Florida. Much of the primary habitat of this species, beach coastal strand and maritime hammock, has been destroyed or altered for residential and commercial construction. Fewer than 1,000 individual plants exist. They are found in small, widely separated populations in Miami-Dade, Broward, and Palm Beach counties, where habitat loss and modification place this species at a high risk of extinction. Habitat conservation and management and reintroduction efforts are needed to make sure of the survival of this species. The information presented here is from the Multi-species Recovery Plan for South Florida

(Service, 1999), which represents a revision of the existing recovery plan for the beach jacquemontia (Service, 1995).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: flowers from November to May

**Reproduction Narrative**

Adult: Beach jacquemontia flowers from November to May, but may vegetatively propagate at any time. The incidence or importance of vegetative propagation is not known at this time. At some sites, beach jacquemontia sets fruit and disperses seed prolifically (Robertson, 1971); however, few seedlings or young plants are ever found near adult plants. Microhabitat conditions and locations relative to adult plants probably play a major role in providing suitable germination sites (Austin, personal communication, 1997; Kernan, personal communication, 1997). For example, at Crandon Park, naturally sown seeds had extremely low germination rates (unmeasurable) compared to seeds taken from this site and germinated under greenhouse conditions (70%). Findings from these investigations indicated that germination rates were highest in more organic soils in the shade, but that the seed viability was short-lived once sowed.

**Habitat Type**

Adult: Coastal dunes/shrubby hammocks

**Environmental Specificity**

Adult: Very Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Pine rocklands and the crest and lee side of coastal dunes. (Based on Ward 1979, Wunderlin 1982.) (NatureServe, 2015). At Crandon Park, Dade County, beach jacquemontia exists on dune faces at the edge of shrubby hammocks. At Hugh Taylor Birch State Recreation Area [SRA], Broward County, beach jacquemontia is located in coastal scrub with little canopy cover and exposed sandy substrate. There, it receives protection from direct ocean winds and sea spray (Lippincott, 1990). Seedling and young beach jacquemontia grow best when shaded. Under natural conditions, young plants are typically found growing in the shade of adjacent shrubs and trees. When mature, beach jacquemontia spread laterals from the rootstock into adjacent exposed sites (Kernan, personal communication, 1997).

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

20 populations (8 natural and 12 introduced) (USFWS, 2021)

**Population Size:**

~700

**Population Narrative:**

The barrier islands within the range of beach jacquemontia are entirely urbanized except for a few small parks and private estates. Johnson et al. (1993) inventoried all tracts of native coastal vegetation in southeast Florida that were four or more hectares in size. They found only 24 tracts of that description in the known range of beach jacquemontia, five of them entirely or mostly in private ownership. These tracts comprised about 87 hectare [ha] of beach strand vegetation in public ownership, 10.5 ha in private ownership, and 26.7 ha of maritime hammock in public ownership. In 1991, less than 1,000 individual plants of beach jacquemontia were known to occur on 12 sites (Austin 1991). Eleven of these sites were in public parks or recreation areas operated by State, county, or local governments in Palm Beach (eight sites), Broward (one site), and Dade (two sites) counties. The only known privately owned site, in Broward County, had just one plant (Johnson et al., 1993; Austin, 1991). A 1995 survey for beach jacquemontia located 450 to 600 plants at ten sites in Dade and Palm Beach counties (Kernan, personal communication, 1995). More than half of these plants were located at two sites: Red Reef Park in Palm Beach County and Crandon Park in Dade County. The remaining plants were scattered in populations of fewer than 50 individuals in Broward, Dade, and Palm Beach counties. As of 1996, beach jacquemontia was known from only nine sites in Dade and Palm Beach counties (Garview, personal communication, 1997; Davis, personal communication, 1997). Eight of these sites contained natural populations, while one site was established from restoration efforts. Several previously known sites have been lost over the past several years, including re-established populations at Coral Cove Park and Gemini Gardens (private), and Juno Beach Park, Nasa (private). There may be an additional historic site in Palm Beach County added if future surveys confirm the presence of beach jacquemontia. Since 1996, surveys have revealed that more beach jacquemontia colonies in Palm Beach County have been lost. Colonies are now known to exist at Carlin Park, Logggerhead Park, Red Reef Park, Red Reef Golf Course, South Beach Park, and South Inlet Park. Gemini Gardens, Atlantic Dunes Park and Spanish River Park were not included in those surveys (Davis, personal communication,1998). Information from specific localities of beach jacquemontia suggests that the species is relatively secure at some sites but susceptible at others. For example, it was collected at South Coral Cove Park, Jupiter Island, Palm Beach County, in 1962, but was not found there in 1990 (Johnson et al., 1993). The disappearance from this site is due to beach erosion and shading from Australian pines (Johnson et al., 1993). Several specimens identified as beach jacquemontia from the Jupiter Lighthouse on the mainland opposite the southern tip of Jupiter Island have been subsequently identified as J. curtissi (Davis, personal communication, 1998). Land clearing for residential development has eliminated beach jacquemontia from other sites in this area (Austin, 1979). Although apparently suitable habitat exists at Blowing Rocks Preserve and Hobe Sound NWR on Jupiter Island, beach jacquemontia has not been found there (Johnson et al., 1993). Surveys conducted in 2003-2004 estimate the total population to be 700 individuals on nine sites (Maschinski et al., 2004). This number is down slightly from the 2003 estimate of 760 individuals on nine of ten existing sites surveyed. The populations at Carlin Park and Loggerhead Park in Palm Beach County experienced a greater than 50% population reduction observed in the fall of 2003, probably due in part to canopy closure caused by encroachment of hardwoods. Two plants were discovered at Lake Worth Inlet in Palm Beach County in 2001, but only one remained in January 2004. Outplanted populations remained steady. At Red Reef Park in Palm Beach County, 15 of 18 outplanted individuals were surviving in January 2004, the same number observed during the 2003 visit. At Bill Baggs State Park in Miami-Dade County, seven of 93 plants remained of the outplanted population in February 2004, with one plant lost since the survey conducted in the previous year.

***Threats and Stressors***

**Stressor:** Loss and degradation of habitat
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss of habitat to urbanization and beach erosion led to the listing of beach jacquemontia as endangered on November 24, 1993 (Service, 1993). The vast majority of beach coastal strand and maritime hammock vegetation, the primary habitat of this species, has been destroyed by residential and commercial construction. Habitat within public lands has also been destroyed or degraded due to construction of parking lots, pedestrian routes, picnic areas, and other modifications for recreational uses. Additional habitat has been lost to beach erosion at some sites (Johnson et al. 1993, Davis, personal communication, 1997).

**Stressor:** Fragile demographics
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The limited geographic distribution, fragmentation of remaining habitat, small sizes of beach jacquemontia populations, and possibility of stochastic natural events make it doubtful that many of the existing populations will persist for 100 years.

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2

**Recovery Actions:**

- To ensure the survival of this plant, the remaining populations of beach jacquemontia on public lands will require active management and a program of propagation, germplasm conservation, and augmentation. Basic demographic, pollination, seed dispersal, seed germination and seed establishment information is needed to recover this endangered species. Successful management will require new surveys for sites that contain beach jacquemontia, complete knowledge of where it existed historically, and surveys for sites within its historic range that would be suitable for re-establishment. In addition, threats to existing and proposed sites posed by commercial and residential development and invasion of exotic species need to be addressed. Because additional protection of beachfront property through fee title acquisition or easement is unlikely due to real estate costs, beach jacquemontia will be best protected and recovered through re-establishment efforts. Greenhouse propagated plants were successfully re-established to three sites in Crandon Park in 1989; however, two plants used in the Coral Cove Beach Dune Restoration Project in 1994 did not survive (Davis, personal communication, 1994). Although this attempt was unsuccessful, we believe the recovery of this species can be partially accomplished through re-establishment as part of dune restoration projects. Dade County is planning to re-establish about 60 beach jacquemontia plants at Bill Baggs Cape Florida SRA, Key Biscayne, Dade County (Carter, personal communication, 1997). It is important to remember that beach jacquemontia should only be re-established in areas within its historic range. Restoration efforts should also consider using other plants that occur naturally with beach jacquemontia, so that more of a representative vegetative complex is re-created. Some of the existing beach jacquemontia sites and many other potentially suitable recipient sites for beach jacquemontia translocation will require removal and control of exotic vegetation as part of the restoration process. It seems that this species does best in sparsely vegetated habitats, and that one of the factors responsible for its decline is the lack of sparsely vegetated areas that are typical of overwashed dunes (Davis, personal communication, 1998). At Crandon Park, herbicides are being used on a few plots where beach jacquemontia is suppressed by St. Augustine grass, and the plants do not seem to be adversely affected. Fire may also play an important role in habitat maintenance for beach jacquemontia as demonstrated by the short-term response to a recent burn on Bear Cut Preserve on Key Biscayne, Dade County (Kernan, personal communication, 1996). The long-term effects of burning will need to be analyzed over the next several years. Mowing or bush-hogging could also be used where fire cannot be safely used, or in areas where the plants currently exist as a result of mowing.

***Conservation Measures and Best Management Practices:***

- IV.RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1999). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Conduct hardwood reduction and invasive species removal to maintain or restore suitable habitat at all populations. • During invasive species (e.g. beach naupaka, Brazilian pepper) removal on dunes, efforts should be made to remove biomass off-site and shift toward open habitat rather than focus on dense replanting. • Increase the smaller populations (less than 30 plants; Tables 1 and 2) through augmentation using the appropriate genetic guidelines and source materials as described in Thornton et al. 2008 and Maschinski et al. 2013 (see section II.C.1.c.) to help ensure preservation of genetic diversity. • Prioritize restoring and maintaining the habitat quality of extant natural and introduced populations over establishing new introduced populations. • Prior to introducing new experimental populations or augmenting extant populations, ensure that a habitat management plan is in effect and being implemented. • Seed collections for long-term storage should be made continuously following CPC guidelines to not harvest more than 10 percent of the annual seed crop of a given population. Seeds should be separated by maternal line to maximize ability to utilize genetic diversity into future research and introduction efforts. Monitoring/Research Activities • Develop survey metrics that are more easily collected and can serve as indicators of population condition, such as patch size, total area occupied, estimated plants counts, shoot counts (quadrat system), or stem density. • Continue to assess, document, and study the impacts sea level rise (shoreline shift, king tide, storm surge, and saltwater intrusion) on this coastal dune species and its habitat. • Promote and increase partnerships to evaluate the current protection status and management needs at each park and to develop cooperative assistance and information sharing plans between parks. • Re-survey populations that do not have recent site visits or are considered extirpated (see Tables 1 and 2). Consider possible habitat management or restoration actions at these sites. • Public access should continue to be managed to prevent trespassing on the dunes and enforce "no trespassing" regulations. Public education should be implemented to educate visitors about this rare species and help control public access to the dunes. • Continue work on genetics (single sequence repeat markers) to further determine degree of genetic differentiation within the J. havanensis clade, to which J. reclinata belongs, and the species' taxonomic status in that clade (Namoff et al. 2008). • Conduct a population viability analysis when enough demographic data are available. Data need to be collected on survival of seedlings in the wild (current data are based on seedlings in a nursery setting). • The role of fire should continue to be explored and understood. On sites where prescribed fire may be used, develop appropriate methods to use fire in small areas in the coastal dune system. (USFWS, 2021)

**References**

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# SPECIES ACCOUNT: *Lasthenia burkei* (Burke's goldfields)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 01/02/1992; Pacific Southwest (R8)

**Physical Description**

An annual herb that ranges in height from approximately 13 cm (5 in) (Patterson in litt. 2000) to as much as 61 cm (24 in) (Greene 1886), but is typically less than 30 cm (11.8 in) tall (Ornduff 1993). It has hairy stems, which may be simple or branched. The narrow, opposite leaves are no more than 8 cm (3.1 in) long and may be lobed or not. From April to June, the end of each branch bears one daisy-like flower head approximately 1.5 cm (0.6 in) across. The fruits are achenes (dry, one-seeded fruits) less than 1.5 mm (0.06 in) in length. The fruits of L. burkei can be distinguished from those of other goldfields by the presence of one long awn (bristle and numerous short scales) (Ornduff 1993). Individual L. burkei plants may exhibit some geographic variation in morphology (McCarten 1985 as cited in CH2M Hill 1995, Patterson et al. 1994). A diagnostic feature of Lasthenia burkei is the usual presence of a single long awn on the achene intermixed with 8 to 10 short scales (Ornduff 1993, Patterson et al. 1994). However, several occurrences have mixtures of typical achenes with a single awn and atypical achenes with a varied number of awns. Species experts consider these mixed occurrences to represent Burke’s goldfields (Ornduff 1969b, Patterson et al. 1994, CNDDB 2013). (USFWS, 2016)

**Taxonomy**

The scientific name originally given to Burke’s goldfields was Baeria burkei (Greene 1886). Both the specific epithet and the common name commemorate J. H. Burke, who collected the type specimen “near Ukiah, Mendocino County” (Greene 1886). Greene later placed the genus Baeria within Lasthenia, creating the new name Lasthenia burkei for Burke’s goldfields (Greene 1894). However, for many years other botanists (e.g., Hall 1914, Jepson 1925, Abrams and Ferris 1960) did not believe that Burke’s goldfields was distinct from Fremont’s goldfields (Lasthenia fremontii), a more widespread species to which it is very similar, nor did they agree with Greene’s (1894) decision to lump Baeria with Lasthenia. Not until 1966, when Ornduff (1966) published a comprehensive study of the genus Lasthenia, was Burke’s goldfields recognized as a distinct species and the name Lasthenia burkei accepted widely. Continuing research indicated that Burke’s goldfields, Fremont’s goldfields, and Contra Costa goldfields (Lasthenia conjugens) form a closely related species group (Ornduff 1969b, Crawford and Ornduff 1989). However, Burke’s goldfields was found to be genetically distinct from Fremont’s and Contra Costa goldfields (Crawford and Ornduff 1989). Lasthenia burkei and its relatives are members of the aster family (Asteraceae). (USFWS, 2016)

**Historical Range**

Endemic to the central California Coastal Range region and has been reported historically to be located within Mendocino, Lake, and Sonoma counties. (USFWS, 2016)

**Current Range**

In California, within Mendocino, Lake, Napa, and Sonoma Counties. (USFWS, 2019). Burke’s goldfields is known only from southern portions of Lake and Mendocino counties and from the Santa Rosa Plain, previously referred to as the Cotati Valley, in Sonoma County. (USFWS, 2024)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: insect-pollinated (USFWS, 2016)

**Lifespan**

Adult: 1 year (USFWS, 2008)

**Dependency on Other Individuals or Species**

Adult: Pollinators (USFWS, 2016)

**Breeding Season**

Adult: April - June (USFWS, 2016)

**Key Resources Needed for Breeding**

Adult: Soil seed bank, insect pollinators. heavy fall rains (USFWS, 2016)

**Other Reproductive Information**

Adult: Like many other rare vernal pool plants, Lasthenia burkei is an annual. Lasthenia burkei typically germinates in autumn following heavy rains, although late initiation of rains may delay seedling emergence (Ornduff 1969b). Laboratory germination tests (Rancho Santa Ana Botanical Garden, unpublished data) indicate that germination occurs rapidly in a single flush, with relatively high germination rates (49 to 100 percent). Both the ray and disk flowers of all goldfields species produce achenes, increasing the potential for seed production per head. However, the reproductive output of individual plants is highly variable, depending on plant density and vigor, and probably on pollinator behavior as well. Each flower head can produce as many as 35 achenes, and the number of flower heads per plant can range from 1 to more than 20 (Patterson et al. 1994). Annual survival rates and other demographic parameters have not been investigated. Lasthenia burkei has also likely adapted to “risky environments” by producing a persistent seed bank. Some occurrences have reappeared after no plants were evident for 2 years, suggesting that viable seeds remained in the soil during that period (Patterson 1990). (USFWS, 2016)

**Reproduction Narrative**

Adult: The flowers of Lasthenia burkei are predominantly pollinated by outcrossing but they are capable of self-pollination (Sloop et al. 2012c). They are thought to be insectpollinated rather than wind-pollinated. Insects known to visit the flowers of the genus Lasthenia include butterflies (Lepidoptera), beetles (Coleoptera), flies (Diptera), true bugs (Hemiptera), bees (Hymenoptera), and wasps (Hymenoptera) (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of Lasthenia spp. are solitary bees (family Andrenidae); these include two species in the subgenus Diandrena (Andrena submoesta and A. puthua) and five or six species in the subgenus Hesperandrena (Andrena baeriae, A. duboisi, A. lativentris, and two or three undescribed species) (Thorp and Leong 1998). Gilmore, Sloop and

Rank (2012) conducted a pollinator study of L. burkei, and found that although the solitary bee (Andrena submoesta) specializes on L. burkei and is apparently dependent on it as a food source, the plant may not rely on A. submoesta for pollination (Gilmore et al. 2012). The Bombyliid fly (also called a bee fly), Conophorus cristatus, was found to be the dominant visitor of L. burkei and may be its primary pollinator. Syrphid flies (members of several genera in the family Syrphidae (hover flies)) were also found to be an important part of the pollinator community for this plant (Gilmore et al. 2012). (USFWS, 2016)

**Habitat Type**

Adult: Wetland (USFWS, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Mesic meadow, vernal pool (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: Wide range, up to 1900 feet in elevation (USFWS, 2016)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: The primary habitats of Lasthenia burkei are shallow vernal pools and wet swales within valley grassland and oak woodland habitats (CNDDB 2013). On the Plain, L. burkei grows in the bottoms of pools ranging from less than 25 cm (10 in) in depth to 50 cm (20 in) (Patterson 1990, Patterson et al. 1994, Patterson in litt. 2000). Lasthenia burkei grows in naturally-occurring pools that range in surface area from approximately 2 square m (21.5 square ft) to 0.3 ha (0.75 ac (Patterson in litt. 2000)). Most of the vernal pools where L. burkei grows are loosely classified as northern vernal pools (Keeler-Wolf et al. 1998), but the Manning Flat occurrence in Lake County is in a northern volcanic ashflow vernal pool (Sawyer and Keeler-Wolf 1995). Lasthenia burkei also has been observed occasionally in artificially-created depressions such as drainage ditches and in disturbed sites such as orchards and disked fields (Patterson 1990, Patterson et al. 1994). (USFWS, 2016)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms are not known. Pappus awns (needle-like appendages attached to the achene) may assist in windborne seed dispersal. Other seed dispersal mechanisms may include water or wildlife. (USFWS, 2016)

***Population Information and Trends***

**Population Trends:**

Decline of >90% (NatureServe, 2015)

**Species Trends:**

> 70% decline (NatureServe, 2015)

**Number of Populations:**

32 (USFWS, 2024)

**Population Size:**

Variable depending on year; 24,860 - 8.1 million in most recently surveyed populations (USFWS, 2016)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

This species inhabits highly vulnerable vernal pool plant endemic to small area, mostly in Sonoma County, California. It has experienced a long term decline of > 90%. It is declining rapidly (> 70% short term) due to runaway urban development in its habitat (Bittman 1998). Numbers fluctuate depending on rainfall; last counts indicated about 100,000 plants at all sites (some may now be extirpated). Known from twenty-eight occurrences. A maximum of twenty occurrences may be extant, but we believe the number to be far lower (fewer than ten viable occurrences) (California Natural Diversity Database, May/1998 report) (NatureServe, 2015). The largest known extant occurrences are at the Alton North Conservation Bank, with approximately 8.1 million plants in 2013; the Alton Lane Vernal Pool Preserve, with approximately 1.4 million plants in 2013; the Wright Preservation Bank, where the number of plants has decreased from approximately 5.3 million down to 1 million over the past 5 years; and Woodbridge Preserve, east of Fulton Road near Piner Road, where the number of plants increased from 350 plants in 1998 to 18.5 million plants in 2009, with 24,860 found at this site in 2012 (CNDDB 2014, Stromberg 2013) (see Figure 5). Sloop and Ayres (2009) found that thirteen Lasthenia burkei occurrences were genetically distinct despite showing some gene flow between them (USFWS, 2016). Currently, the 32 presumed extant occurrences have a similar distribution in these three counties (Diversity Database 2024, entire; see Appendix A). Since the 2019 review, there are two new occurrences in Sonoma County. Occurrence #44 was last seen in 2015, prior to the 2019 review, but was not included in the status review (Diversity Database 2024, p. 48). The second new occurrence, #45, is listed as a transplant outside of native habitat or range; however, it is located within Sonoma County, and the Diversity Database occurrence report notes that there is no record of seed transplants at this location, so it may be a natural occurrence (Diversity Database 2024, p. 49). Hazel Mitigation Bank attempted to establish Burke's goldfields through seeding in created and enhanced wetlands, but these occurrences only persisted a few years and have not been present since (Stromberg 2019, p. 9). Since the last review, there is no new information or monitoring reports from the other conservation banks and preserves described in the 2019 status review (see Service 2019, p. 12) (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Development and conversion to agriculture (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of

Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

**Stressor:** Alteration of hydrology (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

**Stressor:** Off-highway vehicles (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Damage by off-highway vehicles was noted as a threat to this species. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle

driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

**Stressor:** Grazing managment and thatch accumulation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (Phalaris aquatica), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

**Stressor:** Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown;

however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

**Stressor:** Climate change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including B. bakeri, L. burkei, and L. vinculans. (USFWS< 2016)

**Stressor:** Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Chance events constitute a serious threat to Blennosperma bakeri. Because the known occurrences of B. bakeri are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated

populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998). (USFWS, 2016)

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

**Stressor:** Non-native invasive species (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

***Recovery***

**Reclassification Criteria:**

A/1: Seventy-five percent of extant, native occurrences, not protected as of December 2014, within each core area (Windsor Core Area, Alton Lane Core Area, and Lasthenia burkei Southern Core Area) are permanently protected and managed to maintain the habitat and the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that are isolated and/or genetically unique.(USFWS, 2016)

A/2: The following additional habitat is needed in order to delist or downlist L. burkei. New preserves consist of a minimum of 50 ac in the Windsor Core Area, a minimum 400 ac in the Alton Lane Core Area, and a minimum of 400 ac in the Lasthenia burkei Southern Core Area. These preserves will consist of occupied habitat that is not protected as of December 2014. The ecological integrity (e.g., water quality, hydrology, and uplands condition) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to Lasthenia burkei, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future. (USFWS, 2016)

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences or those providing protection to a large occurrence are less than 10 ac. The preserves are as near to new or existing preserves as possible. (USFWS, 2016)

A/4: New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac preserve). The total new preserve acreage in the core areas includes a minimum of 125 ac of vernal pools and swales distributed among the Alton Lane Core Area, Lasthenia burkei Southern Core Areas, and Windsor Core Area. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: All native occurrences, extant as of December 2014, are replicated at 1:2 (tripled in numbers of occurrences) in permanently protected sites in the three core areas. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016)

E/2: The preserves noted in Factor A are occupied by Lasthenia burkei at a density of 500 plants per square meter when measured on a 25- year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrence size and climate change, among other threats, are developed and are being effectively implemented. (USFWS, 2016)

Recovery Priority Number: 2C

**Delisting Criteria:**
A/1: At least 90 percent of native occurrences of Lasthenia burkei, extant as of December 2014, have been protected in perpetuity. (USFWS, 2016)

A/2: New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac preserve). (USFWS, 2016)

E/1: In addition to replication noted in E/1 of the downlisting criteria for Lasthenia burkei, all occurrences in management areas have been replicated at 1:2 at permanently protected appropriate locations. (USFWS, 2016)

E/2: All replicate occurrences in management areas have achieved the same density (500 plants per square meter) as the core area occurrences. (USFWS, 2016)

E/3: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ. Identification of some genetically unique occurrences is not yet known but will be determined during research as defined in the Recovery Plan. (USFWS, 2016)

**Recovery Actions:**
- 1. Protect extant occurrences and potential habitat for Lasthenia burkei. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of Lasthenia burkei including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed

for sites with created occurrences (USFWS, 2019).

- 3. Collect and store seed from all occurrences of Lasthenia burkei. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
- 4. Survey historical locations and other potential habitat (not previously surveyed) where Lasthenia burkei may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for Lasthenia burkei. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on Lasthenia burkei and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of Blennosperma bakeri, Lasthenia burkei, and Limnanthes vinculans. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for Lasthenia burkei. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed

species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)

- 10. Engage and educate the public about Lasthenia burkei recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Burke's goldfields. Some of these recommendations have already been discussed in previous recovery documents (Service 2016, pp. 91–103; Service 2019, p. 5) and remain valid. Recommendations from the recovery plan contain their action number in parentheses (Service 2016, pp. 91–103). 1. Habitat Acquisition, Management, and Restoration. Roughly only 44% of extant occurrences are currently protected. All extant occurrences of and potential habitat for Burke's goldfields present should be protected (Action 1.0). Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and large unprotected areas currently occupied by the species should be given the highest priority. Large, formerly occupied sites that are unoccupied but have a high restoration potential should also be considered. Protected lands must also be adequately managed or restored based on the best available science (Action 7.0). Vernal wetland restoration or creation and subsequent reintroduction of Burke's goldfields may be necessary to maintain occurrences at levels sufficient for survival of the species. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed (Action 8.0). 2. Determine Population Distribution and Abundance through Regular Monitoring. Since the 2019 review, seven of the 36 Diversity Database occurrences have been observed, but most occurrences have not been seen in five to ten years, with Occurrence

#36 recorded as not being seen since 1929. Conducting comprehensive surveys of historical and natural Burke's goldfields Diversity Database occurrences and continuous monitoring of all protected occurrences is vital to understanding population shifts and threats (Action 9.0). To better understand the extent of Burke's goldfields, the Service recommends surveying historical locations and other potential habitat (not previously surveyed) where Burke's goldfields may occur (Action 4.0). These results should also be used to help inform decisionmakers about the acquisition of appropriate sites where Burke's goldfields occur but are unprotected, to suggest sites that could be acquired for restoration, and to develop an adaptive management program that will achieve the recovery of Burke's goldfields. 3. Seed Collection, Research, and Planting. Seed collection and germination and genetic analyses are crucial to understanding which Burke's goldfields occurrences contain the seeds with the highest possibility of success during reintroduction to other locations. The Service recommends collecting and storing Burke's goldfields seeds from extant populations found during comprehensive surveys (Action 3.0). Seed collection results should be compiled into a list that qualitatively describes the environmental conditions of the collection site and the treatment techniques used. Partner groups should conduct further research on the genetic diversity of seedlings from different occurrences, germination success rate, and replanting success rate. 4. Explore the effect of climate change on vernal pool hydrology and species viability. Assess how climate change impacts, including increased variability in temperature and precipitation, more frequent extreme weather events, and a trend of warmer and drier conditions, will impact vernal pool hydrology. Assess how future climate conditions will impact population dynamics through changes in survival, reproduction, and resilience of the soil seed bank. Determine which Burke's goldfields populations are most vulnerable to climate change to prioritize conservation actions. 5. Public and Agency Engagement. Engage and educate the public about Burke's goldfields recovery (Action 10.0). Partner with agencies such as the Department, Army Corps of Engineers, Sonoma County, and the City of Santa Rosa to conduct resource management practices (Action 13.0) (USFWS, 2024).

**References**

USFWS. 2019. Sonoma sunshine (Blennosperma bakeri), Burke's goldfields (Lasthenia burkei) and Sebastopol meadowfoam (Limnanthes vinculans)

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USFWS. 2016. Recovery Plan for the Santa Rosa Plain: Blennosperma bakeri (Sonoma sunshine)

Lasthenia burkei (Burke's goldfields)

Limnanthes vinculans (Sebastopol meadowfoam)

California Tiger Salamander Sonoma County Distinct Population Segment (Ambystoma californiense). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi + 128 pp. USFWS. 2024. 5-YEAR REVIEW Burke's goldfields (Lasthenia burkei). U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 12 pp.

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# SPECIES ACCOUNT: *Lasthenia conjugens* (Contra Costa goldfields)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 06/18/1997; Pacific Southwest (R8) (USFWS, 2017)

**Physical Description**

An annual herb, 1-4 dm tall, that produces showy yellow flower heads in the spring (NatureServe, 2015). The achenes (fruit) of L. conjugens are less than 1.5 millimeters (0.06 inch) long and always lack a pappus (the hair-like or scale-like structures attached to an achene, which assist in dispersal; Ornduff 1969, Ornduff 1993) (USFWS, 2013).

**Taxonomy**

The two closest relatives of Lasthenia conjugens are L. burkei (Burke's goldfields) and L. fremontii (Fremont's goldfields) (USFWS, 2005).

**Historical Range**

Historically occurred in seven vernal pool regions: Central Coast, Lake-Napa, Livermore, Mendocino, Santa Barbara, Santa Rosa, and Solano-Colusa (Keeler-Wolf et al. 1998). In addition, several historical occurrences in Contra Costa County are outside of the defined vernal pool regions (Keeler-Wolf et al. 1998). Ornduff (1966) reported collections from 13 sites in Alameda, Contra Costa, Mendocino, Napa, Santa Barbara, Santa Clara and Solano counties. Although he cited three specimens each from Contra Costa and Santa Barbara Counties, Ornduff (1966; 1979) noted that the species was most common in Solano County. One additional site in Alameda County was documented in 1959 by G. Thomas Robbins, who collected a specimen (# 3963, housed at the Jepson Herbarium) on the "shore of the San Francisco Bay" south of Russell (Service 2005a; USFWS, 2013).

**Current Range**

L. conjugens has been reported in ten counties within California: Alameda, Contra Costa, Marin, Mendocino, Monterey, Napa, Santa Barbara, Santa Clara, Solano, and Sonoma (CNDDB 2012; USFWS, 2013). Currently, the distribution of the species remains as described in our 2013 status review. The Diversity Database now reports 36 occurrences of Contra Costa goldfields (Appendix A; Diversity Database 2023, entire). The two occurrences (occurrences #45 & 46) added to the Diversity Database since the 2013 status review are found in Solano County in proximity to other known occurrences on Travis Air Force Base and are mapped as "transplanted populations" (Diversity Database 2023, p. 41). These occurrences do not represent new populations of Contra Costa goldfields, but are part of ongoing conservation efforts and mitigation for projects on Travis Air Force Base (Collinge 1999, entire) (discussed in Conservation Efforts). These transplanted occurrences are within the previously known range of the species and do not change our understanding of the distribution of the species (USFWS, 2024).

**Critical Habitat Designated**

Yes; 8/6/2003.

**Legal Description**

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lasthenia conjugens (Contra Costa goldfields) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in California (70 FR 46924-46999).

**Critical Habitat Designation**

The critical habitat designation for Lasthenia conjugens includes eight CHUs in Alameda, Contra Costa, Mendocino, Napa, and Solano counties, California. This species critical habitat encompasses approximately 14,730 acres (71 FR 7118-7316).

Unit 1: Mendocino County, California. From USGS 1:24,000 scale quadrangle Point Arena.

Unit 2: Napa County, California. From USGS 1:24,000 scale quadrangles Yountville, Capell Valley.

Unit 3: Napa County, California. From USGS 1:24,000 scale quadrangles Napa, Cuttings Wharf.

Unit 4: Solano County, California. (i) Unit 4A: Solano County, California. From USGS 1:24,000 scale quadrangle Fairfield South. (ii) Unit 4B: Solano County, California. From USGS 1:24,000 scale quadrangles Fairfield South. (iii) Unit 4C: Solano County, California. From USGS 1:24,000 scale quadrangles Elmira, Denverton.

Unit 5: Solano County, California. (i) Unit 5A: Solano County, California. From USGS 1:24,000 scale quadrangle Elmira. (ii) Unit 5B: Solano County, California. From USGS 1:24,000 scale quadrangles Elmira, Denverton.

Unit 6: Contra Costa County, California. From USGS 1:24,000 scale quadrangle Benicia.

Unit 7: Contra Costa County, California. From USGS 1:24,000 scale quadrangles Byron Hot Springs, Clifton Court Forebay.

Unit 8: Alameda County, California. (i) Unit 8A: Alameda County, California. (ii) Unit 8B: Alameda County, California. From USGS 1:24,000 scale quadrangles Milpitas, Niles.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lasthenia conjugens critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described below in paragraph (2)(ii), providing for dispersal and promoting hydroperiods of adequate length in the pools;

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands;

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the areas determined to be essential for conservation may require special management considerations or protections. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species. Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Many of the factors that cause the decline and localized extirpation of vernal pool species can be avoided. Actions that should be avoided include the following: (1) Actions that increase competition from invasive species as many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDB 2001). (2) Alteration of natural hydrology such as construction of dams or other structures that artificially increase the length of vernal pool inundation or construction of ditches that artificially drain vernal pools. (3) Human degradation of vernal pools such as off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2013)

**Lifespan**

Adult: One year (see physical description)

**Breeding Season**

Adult: March - June (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2005)

**Reproduction Narrative**

Adult: L. conjugens flowers from March to June (Ornduff 1966, Ornduff 1976) and is self-incompatible (USFWS, 2013). Although L. conjugens has not been the subject of pollinator studies, observations suggest that the same insects visit all outcrossed species of Lasthenia, rather than concentrating on any particular species (Thorp 1976). Insect visitors to flowers of

Lasthenia belong to five orders: Coleoptera, Diptera, Hemiptera (true bugs), Hymenoptera, and Lepidoptera (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of Lasthenia are solitary bees (family Andrenidae); these pollinators include two species in the subgenus Diandrena (Andrena submoesta and A. puthua) and five or six species in the subgenus Hesperandrena (Andrena baeriae, A. duboisi, A. lativentris, and two or three undescribed species) (Thorp and Leong 1998) (USFWS, 2005).

**Habitat Type**

Adult: Wetland (USFWS, 2013)

**Habitat Vegetation or Surface Water Classification**

Adult: Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow vernal pools (USFWS, 2013)

**Geographic or Habitat Restraints or Barriers**

Adult: Typically occurs < 200 ft. elevation, but may occur up to 1465 ft. (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits vernal pools in open grassy areas at elevations up to 470 m (NatureServe, 2015). Lasthenia conjugens typically grows in vernal pools, swales, and low depressions in open valley and foothill grasslands and have been found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow (Sawyer and Keeler-Wolf 1995). This species is commonly found at elevations less than 61 meters (m) (200 feet (ft)) but has been documented at 445 m (1465ft) in Napa County and at 137 m (450ft) in Monterey County (CNDDB 2012)(USFWS, 2013).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms in Lasthenia conjugens are unknown. However, the lack of a pappus or even hairs on the achenes makes wind dispersal unlikely (Ornduff 1976) (USFWS, 2005).

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

25 presumed extant occurrences (USFWS, 2024)

**Population Narrative:**

Of the 23 presumed extant records, four occurrences may now be extirpated: (1) an occurrence in Mendocino County has not been observed since 1937; (2) an occurrence in Alameda County has not been observed since 1959; (3) in 1987, a single plant was observed in Napa County and has not been documented since; (4) an occurrence in Solano County was noted on a field checklist in1996 and the location is unknown (CNDDB 2012). Ramp Neale et al. (2008) found high levels of genetic diversity and moderate levels of differentiation among populations (USFWS, 2013). Currently, the distribution of the species remains as described in our 2013 status review. The Diversity Database now reports 36 occurrences of Contra Costa goldfields (Appendix A; Diversity Database 2023, entire). The two occurrences (occurrences #45 & 46) added to the Diversity Database since the 2013 status review are found in Solano County in proximity to other known occurrences on Travis Air Force Base and are mapped as “transplanted populations” (Diversity Database 2023, p. 41). These occurrences do not represent new populations of Contra Costa goldfields, but are part of ongoing conservation efforts and mitigation for projects on Travis Air Force Base (Collinge 1999, entire) (discussed in Conservation Efforts). These transplanted occurrences are within the previously known range of the species and do not change our understanding of the distribution of the species. Seven occurrences continue to be considered extirpated and four are considered potentially extirpated (Diversity Database 2023, entire). The majority of the presumed extant occurrences are located in Solano County, where 13 occurrences are presumed extant (Diversity Database 2023, pp. 4–41). Other large concentrations of occurrences are in Monterey County and Alameda County, each with three occurrences (Diversity Database 2023, p. 25). Of the 25 presumed extant records, 4 occurrences may now be extirpated having not been seen for some time or the exact location is unknown (Diversity Database 2023, p. 39): (1) An occurrence (occurrence #16) in Mendocino County has not been observed since 1937; (2) An occurrence (occurrence #37) in Alameda County has not been observed since 1959; (3) A single plant (occurrence #21) was observed in Napa County in 1987 and has not been documented since; and (4) An occurrence (occurrence #43) in Solano County was noted on a field checklist in 1996 and the specific location of the occurrence is unknown. The distribution of Contra Costa goldfields is uncertain due in part to the difficulty of relocating sites and because this species may reappear on a site after several years of it being absent. In December 2022, Vollmar Natural Lands Consulting, as part of the Contra Costa goldfields captive propagation and reintroduction to Contra Costa County project (discussed in Conservation efforts), conducted a status survey of 20 subpopulations associated with 9 known Contra Costa goldfields occurrences (occurrences # 1, 3, 7, 20, 23, 24, 30, & 33). Data from these status surveys have not yet been added to the Diversity Database. Their findings are in line with previous understanding of Contra Costa goldfields habitat requirements. They found that while Contra Costa goldfields occurs in a wide range of habitats, all occupied sites have similar characteristics: grassland habitat grazed by cattle, seasonally wetted soils, and fine-grained soil with high clay or silt content that is likely alkaline. Abundance: The final listing rule provided no abundance data for Contra Costa goldfields. The 2008 status review stated that informal status surveys had occurred at five occurrences and that annual monitoring had been initiated at various localities in Solano County in support of development of the Solano Habitat Conservation Plan (Service 2008, p. 14). The 2013 status review presented the results of informal status surveys conducted at several occurrences and monitoring data for the five Solano County occurrences that were censused annually for 3- or 4-year periods between 2006 and 2011 (Service 2013, p. 6). Overall, Contra Costa goldfields population size can vary greatly season to season based on rainfall and other site-specific factors (e.g., prevalence of invasives, thatch ground cover, grazing practices, etc.). Only a few of the known occurrences have long term monitoring in place from which population dynamics and trends can be identified, which are described below. Initial abundance estimates from the Contra Costa goldfields captive propagation and reintroduction to Contra Costa County project (discussed in Conservation efforts) are presented in Appendix A. Additional years of monitoring are needed to better understand the population dynamics and trends at these locations (Vollmar 2022, pp. 5– 6). The 2019 annual report for the Noonan Ranch Conservation Bank (Conservation Bank) in Solano County, California, was submitted to the Service by LSA Associates, Inc. in February 2020. The report includes the results of the initial years (2008–2013 and 2019) of long-term monitoring for the Contra Costa goldfields population at the Conservation Bank (Occurrence #24). Monitoring for Contra Costa goldfields on the Conservation Bank will continue every five years. Table 1 below provides a summary of the monitoring results through 2019. According to the report, Contra Costa goldfields continues to occur in the majority of the wetlands on the Conservation Bank with distribution, emergence, and density varying within individual wetlands (LSA 2020, entire). Contra Costa goldfields populations are only found within wetlands with specific hydrologic characteristics (LSA 2020, pp. 2–6). Average percent cover on the Conservation Bank during this time period varied from 9.9 percent in 2012 to 31 percent in 2019 (LSA 2020, pp. 2–5). This variation in average percent cover is largely attributed to the number of small wetlands present on the Conservation Bank in a given year. The number of small wetlands with conditions suitable for Contra Costa goldfields germination and growth on the landscape is highly dependent on the seasonal timing of rainfall (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** One of the primary threats to L conjugens is conversion of landuse, for example residential and industrial development, wetland drainage, and agricultural land conversion (including vineyards) (USFWS 2008). Since 65% of this species occurs on private land and is not protected, this is an ongoing problem (USFWS 2008). Just as significant are such associated threats as introduced invasive plants (like Italian ryegrass and waxy mannagrass), recreational uses (such as off-road, equestrian, and mountain bike traffic), road construction and widening, and the resulting habitat fragmentation (USFWS 2008). Other threats to the species include landfill expansion, gravel mining, and both intensive grazing practices and the lack of grazing (USFWS 2008). Moderate grazing (in stocking numbers, frequency, and duration) is important to keeping invasive plants in check and improving soil conditions when burning is not possible (USFWS 2008) (NatureServe, 2015).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, the Service believes other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2013).

**Stressor:** Invasive plants (USFWS, 2013)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from invasive plant species poses a primary threat to this species. Non-native grasses occur commonly in vernal pool complexes and have become a threat to native vernal pool species through their capacity to change pool hydrology. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture. Lolium multiflorum and Glyceria declinata (waxy mannagrass) increase thatch buildup, which leads to increased oxygen depletion in the pools (Dunne and Leopold 1978) and contributes to the shortening of inundation periods through increased evapotranspiration (Marty 2005). As vernal pool complexes become surrounded by residential development and disturbed habitat, the likelihood of invasion by nonnative plants increases (Zedler and Black 2004) (USFWS, 2013).

**Stressor:** Inappropriate grazing regimes (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Both lack of grazing and excessive grazing may cause an increase in organic matter in the habitat that can eliminate the natural vernal pool invertebrate community and promote opportunistic and invasive nonnative species, such as Lolium spp., that outcompete the obligate vernal pool species (Rogers 1998; Rogers 2006). The cessation of cattle grazing has been found to exacerbate the negative effects of invasive non-native plants on vernal pool inundation period. Appropriate levels of grazing may help maintain soil conditions and limit the amount of thatch accumulation near vernal pools (Rogers 2006). Increased grass cover in and around ungrazed pools may lead to an increase in evapotranspiration rates, resulting in a decreased hydroperiod (Marty 2005). In areas where long-term grazing has been in effect, moderate grazing (in both stocking numbers and amount of time) may be an important tool in combating non-native plant species, when burning is not an option. Moderate grazing may be a necessary tool to maintain the species diversity of the natural vernal pool ecosystem (Marty 2005) (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). Lasthenia conjugens is dependent upon vernal pool wetlands that signify the importance of water availability on the survival and recovery for this species. If California receives more rainfall through intense precipitation events, suitable vernal pool habitat for L. conjugens may increase, which would benefit the species. However, if California enters into a drying trend, the resulting droughts could adversely affect L. conjugens. While drought conditions are a normal part of environmental variability in California, a severe drought would exacerbate adverse effects associated with small, disjunct populations of Lasthenia conjugens, and would place additional strains on vernal pool ecosystems (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**

1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. 1A. Suitable vernal pool habitat within each prioritized core area for the species is protected. 1B. Species localities distributed across the species' geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. 1C. Reintroduction and introductions must be carried out and meet success criteria. 1D. Additional localities that are detected (and determined essential to recovery goals) are permanently protected. 1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2013).

2. Adaptive Habitat Management and Monitoring: 2A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E. 2B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.). 2C. Monitoring indicates that ecosystem function has been maintained in areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of postdrought monitoring. 2D. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2013).

3. Status Surveys: 3A. Status surveys, 5-year reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multiyear period that includes above average, average, and below average local rainfall, a multiyear drought, and a minimum of 5 years of post-drought monitoring. 3B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2013).

4. Research: 4A. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. 4B. Research on genetic structure has been completed (for species where necessary - for reintroduction and introduction, seed banking) and results incorporated into a habitat protection plan to ensure that within- and among-population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species has been

completed (USFWS, 2013).

5. Participation and Outreach: 5A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. 5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. 5C. Participation plans for each vernal pool region have been completed and implemented. 5D. Vernal pool region working groups have developed and implemented outreach incentive programs that develop partnerships contributing to achieving recovery criteria 1- 4 (USFWS, 2013).

Recovery Priority Number: 5C

**Delisting Criteria:**
See reclassification criteria.

**Recovery Actions:**
- Protect vernal pool habitat in the largest blocks possible from loss, fragmentation, degradation, and incompatible uses (USFWS, 2005).
- Manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern (USFWS, 2005).
- Conduct range-wide status surveys and status reviews for all species addressed in this recovery plan to determine species status and progress toward achieving recovery of listed species and long-term conservation of species of concern (USFWS, 2005).
- Conduct research and use results to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts (USFWS, 2005).
- Develop and implement participation programs (USFWS, 2005).
- L. conjugens occurrences that are currently protected and managed for the benefit of the species include: (1) the North Suisun Mitigation Bank, in Solano County, (2) Travis AFB, in Solano County, (3) the State Route 4 Preserve, in Contra Costa County, (4) Don Edwards San Francisco Bay NWR, in Alameda County, and (5) the former Fort Ord, in Monterey County. Protection of additional localities of this species is necessary to recover this species. Protecting occurrences in Sonoma, Marin, and Napa Counties should be a priority over the next five years, as this is the northwestern edge of the species' range, and no occurrences in these counties are protected at this time (USFWS, 2013).
- Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans (USFWS, 2013).
- Conduct research at as many of the presumed extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of L. conjugens and other listed vernal pools plants. c. Conduct further research on the genetic structure of the species to determine the feasibility of introducing L. conjugens to biologically appropriate vernal pool regions and soil types from which status surveys

indicate the species has been extirpated (USFWS, 2013).
- Regional vernal pool working groups should be created in regions where L. conjugens is known to occur to aid with monitoring and management efforts (USFWS, 2013).
- Conduct additional research on how L. conjugens is pollinated. If certain insects are found to be important to pollination, and therefore to seed production, their habitat must be protected in each core area to contribute to the recovery of L. conjugens (USFWS, 2013).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Contra Costa goldfields. Some of these recommendations have already been discussed in previous recovery documents (Service 2013, pp. 28–29) and remain valid. 1. The majority of known localities of this species are on private land and not protected. Protection of additional localities is necessary to recover this species. Protecting occurrences in Sonoma, Marin, and Napa counties should be a priority over the next five years, as this is the northwestern edge of the species' range, and no occurrences in these counties are protected at this time. 2. Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. 3. Conduct monitoring and research at as many of the presumed extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species and will aid in the development of methods to ameliorate these threats. b. Conduct research on invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of Contra Costa goldfields and other listed vernal pool plants. c. Conduct further research on the genetic structure of the species to determine the feasibility of introducing Contra Costa goldfields to biologically appropriate vernal pool regions and soil types from which status surveys indicate the species has been extirpated. 4. Regional vernal pool working groups should be created in regions where Contra Costa goldfields is known to occur to aid with monitoring and management efforts. 5. Conduct additional research on how Contra Costa goldfields is pollinated. If certain insects are found to be important to pollination, and therefore to seed production, their habitat should be protected in each core area to contribute to the recovery of Contra Costa goldfields. 6. Expand studies on captive propagation and reintroduction to areas outside of Contra Costa County (USFWS, 2024).

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# SPECIES ACCOUNT: *Layia carnosa* (Beach layia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 05/2/2022; Pacific Southwest (R8) (USFWS, 2022)

**Physical Description**

The unbranched to highly branched plants range up to 6 inches tall and 16 inches across. Characteristics distinguishing Layia carnosa from similar species include its fleshy leaves, inconspicuous flower heads with short, 0.08 to 0.1 inch long white ray flowers and yellow disk flowers, and bristles around the top of the one-seeded achene, or dry fruit (USFWS 1998). The number of seed-heads on individual plants varies with plant size. Typically unbranched, short plants on dry, exposed sites will produce a single head, while highly branched plants in moist dune hollows may produce more than 100 heads (USFWS, 2012).

**Taxonomy**

A member of the sunflower family (Asteraceae) (USFWS, 2012). In 1841, Thomas Nuttall described this species as Madarog/ossa carnosa based on specimens he collected in 1835. In 1843, John Torrey and Asa Gray transferred this species to the genus Layia. In 1892, Edward Greene transferred it to the genus Blepharipappus. However, subsequent taxonomic considerations ofthis species agreed with Torrey and Gray (Munz and Keck 1959; Ferris 1960) (USFWS, 1998).

**Historical Range**

California endemic; Humboldt, Monterey, Marin, and Santa Barbara counties. Believed to be extirpated from San Francisco county (NatureServe, 2015).

**Current Range**

The current distribution includes occurrences spread across six very isolated dune systems (Freshwater Lagoon, Humboldt Bay, mouth of the Mattole River, Point Reyes, Monterey Peninsula, Vandenberg [a part of the Guadalupe-Nipomo Dunes), over about 500 miles of shoreline in northern and central California. Beginning at Freshwater Lagoon Spit in northern Humboldt County, Layia carnosa occurs intermittently over 70 miles of shoreline as far south as the mouth of the Mattole River. From there, it jumps some 170 miles to Point Reyes NS (Marin County), and then another 120 miles to the Monterey Peninsula (Monterey County). From Monterey, a gap of about 150 miles separates it from the southernmost site at Vandenberg AFB, in Santa Barbara County. Five historical occurrences located in San Francisco, Monterey and Humboldt counties are believed to have been extirpated (U.S. Department of the Interior 1998) (USFWS, 2012).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (based on closely related species) (NatureServe, 2015)

**Lifespan**

Adult: One year (USFWS, 2012)

**Breeding Season**

Adult: April - June (USFWS, 2012)

**Key Resources Needed for Breeding**

Adult: Spring rains (NatureServie, 2015)

**Reproduction Narrative**

Adult: Based on other Layia species, which are self-incompatible, this species would be an obligate outcrosser. It is dependent on spring rains as an annual (NatureServe, 2015). As a winter annual, Layia carnosa germinates during the rainy season between fall and mid-winter, blooms in spring (April to June), and completes its life cycle before the dry season (USFWS, 2012). The number ofseed-heads on individual plants varies with plant size, ranging from unbranched, short, erect plants on dry, exposed sites with a single head to highlybranched plants in moist hollows in dunes with over 100 heads (USFWS, 1998).

**Habitat Type**

Adult: Terrestrial (USFWS, 2012)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal sand dune (USFWS, 2012)

**Geographic or Habitat Restraints or Barriers**

Adult: Excessive shading (inferred from USFWS, 2012); typically occurs between 0 - 100 ft. elevation (USFWS, 2012)

**Spatial Arrangements of the Population**

Adult: Patchy colonies (USFWS, 2012)

**Environmental Specificity**

Adult: Very narrow (Natureserve, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (USFWS, 2012)

**Habitat Narrative**

Adult: The environmental specificity is very narrow; it is only known from narrow coastal strand in three main areas in California (NatureServe, 2015). Populations tend to be patchy and subject to large annual fluctuations in size and dynamic changes in local distribution associated with the shifts in dune blowouts, remobilization, and natural dune stabilization that occur in the coastal dune ecosystem. Colonies often occur where sparse vegetation traps wind-dispersed seeds, but causes minimal shading. Layia carnosa is restricted to openings in coastal sand dunes ranging in elevation from 0 to over 100 feet, where it colonizes sparsely vegetated, semi-stabilized dunes and blowouts. The species often occurs in narrow bands of moderately disturbed habitat along the edges of trails and roads (USFWS, 2012).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are dispersed by wind mostly during late spring and summer months (USFWS 1998; USFWS, 2012).

***Population Information and Trends***

**Population Trends:**

Decline of 50-70% (NatureServe, 2015); stable distribution since listing (USFWS, 2012)

**Number of Populations:**

18 (NatureServe, 2015)

**Population Size:**

Unknown, > 10 million (USFWS, 2012)

**Adaptability:**

Low (NatureServe, 2015)

**Population Narrative:**

Highly vulnerable due to annual habit and sensitivity of coastal habitat. Long term trend is severe decline (50-70%). Numbers of this annual fluctuate depending on spring rain and available open sand. In 2005, the CNDDB knew of 24 total EO's, 6 of which were historical or extirpated (NatureServe, 2015). No significant change in the distribution of Layia carnosa has occurred since the species was listed. Accurate estimation of population size is difficult and costly for diminutive, short-lived annual species such as Layia carnosa, which tends to occur in small patches scattered across large areas of habitat. Overall total habitat occupied by Layia carnosa, based on data collected between 1999 and 2010, is estimated on the order of 456 acres, which may be conservative given the difficulty in detecting the plant and conducting thorough surveys. The Humboldt Bay population clearly is the largest across the range, likely exceeding 10 million individuals. The population at the mouth of the Mattole, estimated in the millions, occupies about 27 acres, and at least for the present, is relatively free of invasive species. The Point Reyes population has not been accurately censused, but appears to number in the 10’s of thousands or higher (USFWS, 2012).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threat of off-road vehicles has reduced significantly, with the exception of some of the privately held habitat located in Humboldt County. The remaining occupied habitat most susceptible to human destruction or modification includes the dunes located near the mouth of McNutt Gulch, and the Signal Hill Dunes on the Monterey Peninsula. Although livestock trampling

was indicated as a threat when Layia carnosa was listed, the only population known to be currently exposed to livestock is near the mouth of McNutt Gulch. No information is available on the size of that population, or degree of impacts by livestock. Many populations of Layia carnosa across its range continue to be impacted by uncontrolled pedestrian or equestrian traffic. However, evidence suggests that, for many sites where natural dune processes may be lacking, at least some recreation-related mortality may be a necessary consequence of the need for adequate disturbance to preclude overstabilization of the habitat. Acute levels of foot traffic clearly directly eliminate Layia carnosa from the center of traveled pathways, but at the same time, monitoring data and anecdotal evidence has consistently documented a strong preference by Layia carnosa for moderately disturbed habitat located along roads and trails (whether pedestrian or equestrian) in what otherwise would be unoccupied habitat.

**Stressor:** Climate change (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is expected that sea level may rise at least 16 inches along the California coast by 2050, with a 50-inch rise predicted by 2100 (Heberger et al. 2009). Beyond the direct influence of ocean-rise in potentially inundating the lower range of Layia carnosa habitat, even small changes in water level may cause significant changes in wave energy and the potential for shoreline damage from wave forces (California Coastal Commission 2001). Another coastal process that has the potential to affect Layia carnosa habitat, at least at Humboldt Bay, is vertical land deformation. Recent investigation suggests that deformation is occurring both during and between seismic events, and appears to vary in its direction (i.e., subsidence or uplift) and magnitude across the bay region (Walters 2011). Enhanced dune erosion may already be occurring in portions of the Humboldt Bay dune system, evidenced by the recent development of two unusually large, moving dune blowouts that show no sign of stabilizing, as well as a general loss of dune habitat on the North Spit (A. Pickart, pers. comm. 2011b) (USFWS, 2012).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While those and other statutes (CEQA, California Coastal Act, Federal Coastal Zone Management Act) all provide limited protections for Layia carnosa on private and public property, many of its current threats are either unregulated, or of a kind not affected by land use regulations (invasive species encroachment, pedestrian impacts). Thus regulatory restrictions, even when applicable, are currently inadequate to conserve this species (USFWS, 2012).

**Stressor:** Invasive plants (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Layia carnosa was listed, in part, due to the past introduction and invasion of its habitat by a variety of invasive, non-native plant species. These species threaten virtually the entire distribution of Layia carnosa, through direct competition for space, stabilization of the dunes, and in some cases, enrichment of the soils which then stimulates invasion by other aggressive species. In Humboldt County the primary threats are invasive annual grasses,

European beachgrass, yellow bush lupine, iceplant, and jubata grass (Cortaderia jubata). Iceplant, annual grasses, and in some cases European beachgrass, are the primary threats farther south in its range. Evidence suggests these taxa will continue to invade Layia carnosa habitat, necessitating routine and long-term management action. While the threat posed by invasive species has been addressed to some extent, at least temporarily, no mechanism has been implemented which ensures continued funding and implementation of an invasive species control program, or the monitoring necessary to effectively implement such a program (USFWS, 2012).

**Stressor:** Stochastic events (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Annual species such as Layia carnosa are vulnerable to random fluctuations (stochasticity) and variation in annual weather patterns or other environmental factors (USFWS 1998). All of the Monterey and Santa Barbara County populations, and the Freshwater Lagoon Spit site in Humboldt County, due to their relatively small size and area of occupied habitat, continue to be vulnerable to stochastic extinction (USFWS, 2012).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 8

**Delisting Criteria:**
Protection ofhabitat presently occupied by the species, with long-term commitments to conserving the species and the native vegetation (USFWS, 1998).

In protected habitat, successful control ofinvasive non-native plants (and snails) and successful management oflesser problems, including grazing, pedestrians, and off-road vehicles. Management success must be demonstrated through ten years of biological monitoring. The time is needed to observe the effectiveness ofmanagement in dry and wet years (USFWS, 1998).

The threatened Chorizanthe pungens var. pungens may be considered for delisting when permanent protection has been implemented, as currently planned, in the Fort Ord disposal and reuse process and the coastal populations receive protected status (USFWS, 1998).

**Recovery Actions:**
- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plants and butterfly (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).

- Develop and implement an outreach program (USFWS, 1998).
- Continued collaboration with Redwood NP, CDPR, BLM, Manila CSD, City of Eureka, Point Reyes NS, Vandenberg AFB, and perhaps private landowners is essential to the successful recovery of this species (USFWS, 2012).
- The type locality population for Layia carnosa at the Point Pinos dunes has not been detected since 1919 (CDFG 2007). The Point Pinos dunes are currently undergoing restoration and endangered species augmentation as part of a plan related to expansion of the golf course and transfer of the property from the US Coast Guard to the City of Pacific Grove. Unfortunately Layia carnosa was not included in the restoration plan. An attempt should be made to reintroduce Layia carnosa to Point Pinos from seed collected at nearby Asilomar SB or Indian Dunes. Whether or not the recovery goal for that population can be met is unknown. However, the attempt to establish a vigorous population there is called for under one of the delisting criteria, and could reestablish a historically significant population. In addition, the planned reintroduction of Layia carnosa to restored habitat near the historical occurrence at the mouth of Little River should be pursued (Forys 2006) (USFWS, 2012).
- Population and Occupied Habitat Inventories: Habitat owned by the USFWS, BLM, City of Eureka, Manila CSD, Point Reyes NS, CDPR and Pebble Beach Company (Indian Village Dunes) have been the focus of one or more dunes restoration projects. Periodic reassessment of these populations and occupied habitat at these sites, employing consistent methodology, is critical to establish trends, provide feedback on the restoration efforts, and determine whether the current recreational management is compatible with conservation of the species. Baseline population and habitat inventories are needed for the City of Eureka Elk River Spit, the privately held dunes near the mouth of McNutt Gulch, and the Signal Hill site owned by Pebble Beach Company on the Monterey Peninsula. Where populations are too large to census, a uniform methodology similar to that utilized by the USFWS and BLM at Humboldt Bay should be adopted (USFWS, 2012).
- Disturbance Monitoring: Habitat disturbance is known to be a necessary element in the ecology of Layia carnosa; however, too much or too little disturbance is detrimental. Therefore, in order to effectively tailor recreational management to the needs of Layia carnosa, quantitative data are needed indicating its response to specific recreational use. Research is needed to measure the rate of establishment and mortality of Layia carnosa in response to varying types and levels of disturbance (USFWS, 2012).
- Priorities for increased protection, by fee acquisition, conservation easement, or other legal protective mechanism, include: • Signal Hill Dunes, on the Monterey Peninsula • City of Eureka dunes habitat located on the North Spit, and Elk River Spits of Humboldt Bay. • Private owned dunes habitat on the North Spit of Humboldt Bay, and north of the mouth of the Mattole River. The monitoring and restoration conservation easement proposed by Pebble Beach Company as part of the Spyglass Hill Golf Course project could serve as a template for future agreements needed to ensure future conservation of critical dunes habitat for this species. Such agreements would in many cases contribute to recovery of multiple listed species, including the Monterey spineflower (Chorizanthe pungens var. pungens, sand gilia (Gilia tenuiflora ssp. arenaria), Tidestrom's lupine (Lupinus tidestromii) and Menzies' wallflower (Erysimum menziesii ssp. menziesii) on the Monterey Peninsula; Tidestrom's lupine at Point Reyes NS; and Menzies wallflower (E. m. Eurekense) in the Humboldt Bay portion of the range (USFWS, 2012).

- Due to the vulnerability of its habitat to stabilization by invasive species, and as a result, the highly transient nature of its habitat, the requirement to ensure future maintenance of Layia carnosa habitat is paramount to the recovery effort. It is imperative that efforts to control invasive species continue across the range, and that restoration methods incorporate the most cost-effective means available. Manual removal, or where existing populations will not be impacted, mechanical removal or burning followed with herbicide post-treatment has shown to be particularly effective. The problem species could change overtime, but inevitably, encroachment by invasive species and resulting over-stabilization of its habitat will continue to threaten Layia carnosa in perpetuity. Therefore, habitat monitoring followed by removal of invasive species, when warranted, must be considered a permanent element in maintaining Layia carnosa, even after the delisting (USFWS, 2012).
- Efforts should be made to determine which of the following three options for ensuring long-term protection best applies to individual sites and ownership: 1) endowment of conservation easements specifically written to include the necessary monitoring and habitat maintenance needed to conserve the species; 2) incorporation of language within the management guidance documents for each of the agencies that own property supporting significant populations of Layia carnosa, which emphasizes invasive species monitoring and control efforts in perpetuity, and at least some level of Layia carnosa population monitoring, even after it is delisted; 3) implementation of conservation agreements which combine the necessary elements of the above two options in ensuring future maintenance of Layia carnosa habitat after it is delisted (USFWS, 2012).
- Permanent Funding: With respect to the privately held habitat, the level of funding necessary to adequately monitor Layia carnosa populations and habitat, and implement maintenance actions prior to onset of population decline needs to be determined. Opportunities should then be pursued to secure permanent funding in the form of an endowment or trust fund, which ensures that the responsive management is conducted in perpetuity (USFWS, 2012).
- The California Shoreline Mapping Project, implemented in 2010, will provide high resolution LIDAR photography enabling development of accurate DEM’s (California Ocean Protection Council 2011). Those data should be analyzed in conjunction with occupied habitat maps and periodic population monitoring data for sites across the range, particularly the Humboldt Bay, Mattole River, and Point Reyes populations, to help evaluate future trends in population and habitat as they correlate with elevation (USFWS, 2012).
- Future dunes habitat restoration projects across the range, but most importantly at Humboldt Bay, the mouth of the Mattole River, and at Point Reyes should utilize elevation data available from the DEM for those areas, and begin focusing restoration efforts in areas at sufficient elevation, and if possible, located geographically so as to insulate Layia carnosa as much as possible from the effects of ocean-rise (USFWS, 2012).
- Research should include a comparison of climate and soil factors, and other factors that may affect reproductive success in populations of Layia carnosa, both at the limits of its range, and within the center of its range (for example, Humboldt Bay). As soon as those results are available, the feasibility and practicality of meeting the existing delisting recovery criteria for the species should be evaluated, and recommendations made regarding adequacy of the existing recovery criteria (USFWS, 2012).
- Focused inventories for Layia carnosa should be conducted at all the significant dune systems located along the coast between the Monterey Peninsula and Vandenberg AFB, which constitutes a 150 mile long gap in the known distribution for the species (USFWS,

2012).

- Initial efforts have been made to restore near-shore dunes habitat at Vandenberg AFB, and expand the relatively small population of Layia carnosa. The results of the Layia carnosa life history study, scheduled to be initiated in fall 2011, hopefully should indicate whether range limiting factors, or simply the absence of an appropriate disturbance regime is preventing this population from expanding. Due to the fact it is the southernmost site for the species, and in accordance with the recovery plan, seed from this site should be deposited at an approved seedbank as soon as adequate seed are available (USFWS, 2012).

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# SPECIES ACCOUNT: *Leavenworthia crassa* (Fleshy-fruit gladecress)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015) 8/1/2014

**Physical Description**

A winter annual from a basal rosette of leaves. Flowers (March-May) are whitish-yellow with yellow to orange claws. the first flowers are borne on erect stalks; those forming later usually are borne in loose clusters on true stems arising from the axils of the rosette leaves. Fruits are fleshy, 6-12 mm long. (NatureServe, 2015)

**Taxonomy**

Two questionably distinct varieties (crassa and elongata) are often recognized (e.g., Rollins, 1993; Kartesz 1994 and 1999). The USFWS (2004) does not maintain the varieties, citing evidence that the ranges of variation in fruit lengths overlap (McDaniel and Lyons, unpublished status report, 1987). (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to a 13-mile radius area in Lawrence and Morgan counties in northwest Alabama. (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 8/26/2014.

**Legal Description**

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Leavenworthia crassa under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Alabama (79 FR 50990-51039).

**Critical Habitat Designation**

The critical habitat designation for Leavenworthia crassa includes seven CHUs in Lawrence and Morgan Counties, Alabama. This species critical habitat encompasses approximately 20.6 acres (ac) (8.4 hectares (ha)) (79 FR 50990-51039).

Unit 1: Bluebird Glades: Unit 1 consists of 0.2 ha (0.5 ac) of privately owned land located in southeast Lawrence County, Alabama. The unit contains two subpopulations and is located along Alabama State Route 157 approximately 3.5 km (2.2 mi) southeast of the intersections of State Routes 36 and 157, approximately 3.7 km (2.3 mi) southwest of Danville, Alabama. These plants are located within a highly disturbed, limestone glade within a former mobile home site. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glades and possible changes in land use, including road widening or development. Due to human-caused disturbances, exotic species, most notably Chinese privet and Japanese honeysuckle, threaten this site (Schotz 2009, pp. 13–14).

Unit 2: Stover Branch Glades: Unit 2 consists of 3.2 ha (7.8 ac) of privately owned land located in southeast Lawrence County, Alabama. The unit contains two subpopulations; one subpopulation is located on the southwest side of County Road 203 approximately 1.4 km (0.9 mi) southsoutheast of Alabama State Route 157, and one subpopulation is located along the southwest side of State Route 157, approximately 1.6 to 2.1 km (1 to 1.3 mi) southeast of State Route 36, in Speake, Alabama. These subpopulations are located within a pasture and are actively maintained by livestock grazing. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant’s reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 15–16).

Unit 3: Indian Tomb Hollow Glade: Unit 3 consists of 0.5 ha (1.1 ac) of federally owned land located within the Bankhead National Forest in Lawrence County, Alabama. The unit is located on the west and northwest side of County Road 86 at a point roughly 4.5 km (2.8 mi) south of State Route 36 near Speake, Alabama. Habitat in this unit consists of a relatively small glade characterized by a flat limestone outcrop that is heavily buffered by nearly impenetrable tangles of eastern red cedar and upland swamp privet. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The U.S. Forest Service provides management to control encroachment of invasive species (PCE 3). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glade and damage from vehicles. Moderate encroachment of exotic species, most notably Chinese privet and Japanese honeysuckle, threatens this site along the glade periphery (Schotz 2009, pp. 18–19). This site also shows minimal incidence of trash disposal and damage from recreational vehicles.

Unit 4: Cedar Plains South: Unit 4 consists of 0.04 ha (0.1 ac) of privately owned land located in Morgan County, Alabama. This unit is located on Cedar Plains Road, 1.2 km (0.75 mi) south of County Road 55 and approximately 8 km (5 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. This population represents an excellent landscape context but contains the smallest number of plants of any of the known occurrences. Habitat in this unit consists of a well-lighted limestone glade opening (PCE 2) located within a limestone forest primarily comprised of eastern red cedar and various other hardwoods. Herbaceous vegetation characteristic of glade communities is present within the well-lighted glade (PCE 1), and competition and shading from native and invasive, nonnative plants are currently not a threat to the habitat in this unit (PCE 3). The features essential to the conservation of the species in this unit may require special management considerations or protections to prevent future adverse effects due to competition and shading caused by encroachment of native and invasive, nonnative plants.

Unit 5: Cedar Plains North: Unit 5 consists of 1.7 ha (4.2 ac) of privately owned land located in Morgan County, Alabama. This unit is located on Cedar Plains Road, from 0.6 to 1 km (0.4 to 0.6 mi) north of County Road 55, approximately 8 km (5 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. These populations are located within a pasture and are actively maintained by livestock grazing. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. This glade complex, although subjected to ongoing agricultural interests, represents the greatest concentration of plants currently known for the species. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 23–24).

Unit 6: Massey Glade: Unit 6 consists of 2.75 ha (6.8 ac) of privately owned land located in Morgan County, Alabama. This unit is located on County Road 55, 0.3 to 0.6 km (0.2 to 0.4 mi) west of Cedar Plains Road, approximately 8.3 km (5.2 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. This population is located within a highly disturbed complex of limestone pavement barrens scattered in an actively utilized pasture and within the yards and fields of nearby homes. Welllighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 25–26).

Unit 7. Hillsboro Glade: Unit 7 consists of 0.04 ha (0.1 ac) of privately owned land in Lawrence County, Alabama. This unit is currently occupied and is located within a powerline right-of-way approximately 400 feet south of the intersection of County Roads 217 and 222, near Hillsboro. Habitat in this unit consists of a relatively small limestone glade outcrop within a powerline right-of-way that is bordered by a forested area. Wellilluminated, open areas (Primary Constituent Element (PCE 2), with shallow soils and exposed limestone bedrock that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glades, indiscriminate herbicide use or mowing for electrical transmission line right-of-way maintenance, and possible changes in land use, including agriculture or development.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Leavenworthia crassa critical habitat consists of three components (79 FR 50990-51039):

(i) Shallow-soiled, open areas with exposed limestone bedrock or gravel that are dominated by herbaceous vegetation characteristic of glade communities.

(ii) Open or well-lighted areas of exposed limestone bedrock or gravel that ensure fleshy-fruit gladecress plants remain unshaded for a significant portion of the day.

(iii) Glade habitat that is protected from both native and invasive, nonnative plants to minimize competition and shading of fleshy-fruit gladecress.

**Special Management Considerations or Protections**

The features essential to the conservation of fleshy-fruit gladecress may require special management considerations or protection to reduce the following threats: (1) Actions that remove the soils and alter the surface geology of the glades; (2) building or paving over the glades; (3) construction or excavation up slope that alters water movement (sheet flow or seepage) down slope to gladecress sites; (4) planting trees adjacent to the edges of an outcrop resulting in shading of the glade and accumulations of leaf litter and tree debris; (5) encroachment by nonnative and native invading trees, shrubs, and vines that shade the glade; (6) the use and timing of application of certain herbicides that can harm gladecress seedlings; and (7) access by cattle to gladecress sites where habitat and plants may be trampled. Management activities that could ameliorate these threats include (but are not limited to): (1) Avoiding limestone glades when planning development, conversion to agriculture, and other disturbances to glade complexes; (2) avoiding above-ground construction and/or excavations in locations that would interfere with natural water movement to gladecress habitat sites; (3) locating suitable habitat and determining the presence or absence of the species and identifying areas with glade complexes and protecting or restoring as many complexes as possible; (4) reaching out to all landowners, including private and State landowners, to raise awareness of the plant and its specialized habitat; (5) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; (6) avoiding pine tree plantings near glades; and (7) managing, including brush removal, to maintain an intact native glade vegetation community. More information on the special management considerations for each critical habitat unit is provided in the individual unit descriptions below.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2013)

**Reproduction Narrative**

Adult: Fleshy-fruit gladecress is an annual, spring-flowering member of the mustard family (Brassicaceae). As an annual, the seeds germinate in the fall, overwinter as rosettes, and commence a month-long flowering period beginning in mid-March. The first seeds mature in late April, and during most years the plants dry and drop all of their seeds by the end of May. It is unlikely that all seeds produced in spring germinate the next fall, but the length of dormancy in the soil is not known (McDaniel and Lyons 1987, p. 10); thus we do not know whether the species is capable of forming a seed bank. Native bees in the families' Andrenidae and Halictidae (sweat bees), including the species Halictus ligatus (sweat bee), were observed carrying pollen from Leavenworthia crassa (fleshy-fruit gladecress) and L. alabamica (Alabama gladecress) in northern Alabama (Lloyd 1965) (USFWS, 2013).

**Habitat Type**

Adult: Glades (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2013)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from USFWS, 2013)

**Site Fidelity**

Adult: High (inferred from USFWS, 2013)

**Habitat Narrative**

Adult: This species is a component of glade flora and occurs in association with limestone outcroppings. The terms ‘‘glade’’ and ‘‘cedar glades’’ are used interchangeably to refer to shallow soiled, open areas that are dominated by herbaceous plants and characterized by exposed sheets of limestone or gravel. Eastern red cedar (Juniperus virginiana) trees are frequent in the deeper soils along the edges of the glades (Hilton 1997, p. 1; Baskin et al. 1986, p. 138; Baskin and Baskin 1985, p. 1). Glades can vary in size from as small as a few square meters to larger than 1 square kilometer (km2) (0.37 square miles (mi2)) and are characterized as having an open, sunny aspect (lacking canopy) (Quarterman 1950, p. 1; Rollins 1963, p. 5). Historically, glades in northern Alabama occurred as glade complexes where sparsely vegetated patches of exposed, or nearly exposed, limestone occurred in a matrix of woody vegetation to form a mosaic of habitats grading into one another (Hilton 1997, pp. 1, 5, 64). Herbaceous diversity was irregular over these complexes, affected by changes in soil gradient and moisture, and the presence or absence of a woody vegetation component. Few undisturbed examples of this community type remain (Hilton 1997, pp. 5, 8; McDaniel and Lyons 1987, p. 11; Baskin and Baskin 1985, p. 1; Rollins 1963, p. 5–6) (USFWS, 2013). High ecological integrity of the population and site fidelity along with low tolerance ranges are inferred based on this species specific habitat requirements.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Resiliency:**

In the Status Quo scenario, resilience is expected to remain the same for most populations in 20 years. While both Danville populations are likely extirpated in the future given the poor condition of all resilience factors, the drastic change in the resilience of the Cedar Plains South population is due population size becoming a limiting factor in the viability of this population. In the Increased Management scenario, resilience for all populations is expected to increase, as habitat management increases both the habitat and land use condition. Even with the downranking of land use condition for populations under private ownership, the majority of populations are assessed to be resilient (e.g., high or very high resilience) under this scenario. In the Introductions scenario, the initial population size of new populations will be determined by the introduction strategy (number of plants, timing of plantings, locations). The overall resilience of introduced populations in the Introductions scenario cannot be quantitatively assessed at this time. (USFWS, 2020a)

**Representation:**

Representation and redundancy is reduced for L. crassa in the Status Quo, increased in the Increased Management and could be greatly increased in the Introductions scenario. Under the Status Quo scenario, two resilient populations remain, with one containing both SI and SC individuals, and one with an unknown mating system. The Increased Management scenario does not lose any populations, and resilient populations include one SI, one SI/SC, two SC, and two with an unknown mating system. The Introductions scenario could focus on gathering seed from populations likely to become extirpated under Status Quo that also utilize mating systems that are not well represented, or that better contribute to genetic diversity and adaptive potential (e.g., SI). The total number of resilient populations should increase from three currently to nine under the Introductions scenario, given increased management is also co-occurring. If populations are added at the same rate (three per decade) following the initial 10-year planning period (and all populations are robust), the Introductions scenario could add 12 resilient populations within 50 years. To achieve eight to ten introduced populations in 50 years, the introduction program would need to maintain its momentum, though two to four introduced populations could be below resilient status (not assessed as having high or very high resilience) and the introduction goal could still be met within a 50-year period. (USFWS, 2020a)

**Redundancy:**

Representation and redundancy is reduced for L. crassa in the Status Quo, increased in the Increased Management and could be greatly increased in the Introductions scenario. Under the Status Quo scenario, two resilient populations remain, with one containing both SI and SC individuals, and one with an unknown mating system. The Increased Management scenario does not lose any populations, and resilient populations include one SI, one SI/SC, two SC, and two with an unknown mating system. The Introductions scenario could focus on gathering seed from populations likely to become extirpated under Status Quo that also utilize mating systems that are not well represented, or that better contribute to genetic diversity and adaptive potential (e.g., SI). The total number of resilient populations should increase from three currently to nine under the Introductions scenario, given increased management is also co-occurring. If populations are added at the same rate (three per decade) following the initial 10-year planning period (and all populations are robust), the Introductions scenario could add 12 resilient populations within 50 years. To achieve eight to ten introduced populations in 50 years, the introduction program would need to maintain its momentum, though two to four introduced populations could be below resilient status (not assessed as having high or very high resilience) and the introduction goal could still be met within a 50-year period. (USFWS, 2020a)

**Number of Populations:**

8 (USFWS, 2020)

**Population Narrative:**

Being a seed-banking winter annual, this species has good survival but poor competitive abilities (USFWS 2004). The very low numbers of fruiting individuals seen most years suggest that the populations may be highly vulnerable to stochastic factors as well. The plants are usually self-incompatible (Rollins 1993), thus requiring cross-pollination for seed production. However, given proper habitat conditions, this species is able to grow and reproduce quickly. More than 50% of the appropriate glade habitat has been lost in north-central Alabama, with only five glades remaining in good condition (Hilton 1997 cited by Everson 2009). Fifteen historical occurrences have been lost. Also, the range may have contracted significantly, if an unconfirmed historical record from Lauderdale County is accepted. Some of the extant occurrences have been degraded by grazing, road construction, and plowing or cultivation (Everson 2009). Decline of 70-90% Population size value left blank for this seed-banking annual because the large number of individuals suggests a sense of security that is not warranted. Abundant locally, with some sites containing thousands of individuals. Individual populations range from <50 individuals to up to 10,000. In March 2009, a total of approximately 12,000 individuals were counted in the six occurrences (Schotz 2009). Endemic to northwest Alabama, where six occurrences were verified extant in 2009 (Schotz 2009) (NatureServe, 2015). NatureServe (2015) notes that the short term trend is a decline of 30-50% and the Long-term trend is a decline of 70-90%. USFWS (2013) notes there are 5 extant populations. Low resiliency, representation and redundancy are inferred based on the number of populations and the relatively small geographic area this species is known to inhabit. The Service is aware of ten occurrences of fleshy-fruit gladecress in eight populations in the Moulton and Tennessee valleys in Alabama, with four occurrences discovered 2008–2016 and one occurrence newly discovered since listing (Service 2019). One additional occurrence was extirpated prior to the species listing in 2014. Little trend data is available for these populations, but the Service has no evidence any extant population known at the time of listing is extirpated. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Agricultural conversion (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Conversion of this species habitat to agriculture (pasture) is listed as a threat to this species (USFWS, 2013).

**Stressor:** Incompatible agricultural practices (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Agricultural practices such as herbicide use at the wrong time of year are listed as a threat to this species (USFWS, 2013).

**Stressor:** Rights-of-way maintenance (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Rights-of way maintenance (including herbicide use and mowing prior to seed set) is listed as a threat to this species (USFWS, 2013).

**Stressor:** Industrial development (USFWS, 2013)
**Exposure:**
**Response:**

**Consequence:** Loss of habitat
**Narrative:** Industrial development is listed as a threat to this species (USFWS, 2013).

**Stressor:** Shading and competition (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Shading and competition by non-native exotic plants and natural forest succession are listed as a major threat to this species (USFWS, 2013).

**Stressor:** Off-road vehicle use (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individual plants
**Narrative:** Off-road vehicle use is listed as a threat to this species (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2

CRITERION 1. At least 15 geographically distinct populations – separated by at least 1 kilometer – of at least moderate size (at least 100 individuals) are distributed across the species' range, maintaining a mixture of self-incompatible and self-compatible populations, with each of the 2 known ecoregions (Eastern Highland Rim and Dissected Plateau)1 supporting at least 6 such populations, including 1 population within each of the 7 designated critical habitat units (USFWS, 2023).

CRITERION 2. At least 3 large populations (at least 500 individuals), protected by long-term conservation mechanisms, occur in each of the two known ecoregions, for a total of 6 protected populations, and are managed to promote open-canopied habitat, native plant community integrity, and support resilient populations2 of fleshy-fruit gladecress (USFWS, 2023).

CRITERION 3. Monitoring demonstrates that these populations (described in Criteria 1 and 2) are viable, as evidenced by natural recruitment and having stable to increasing populations for at least 10 years (approximately 10 generations) (USFWS, 2023).

**Delisting Criteria:**
Fleshy-fruit gladecress may be considered for delisting when the above criteria are met and when: CRITERION 4. At least 15 additional geographically distinct populations of at least moderate size occur within the species' known range for a total of at least 30 extant populations (USFWS, 2023).

CRITERION 5. At least 2 additional large populations are protected and managed as described in Criterion 2 within each of the 2 known ecoregions, for a total of at least 10 protected populations (USFWS, 2023).

CRITERION 6. Monitoring demonstrates that these additional populations (described in Criteria 1, 2, 4, and 5) are viable, as evidenced by natural recruitment and having stable to increasing populations for at least 10 years (approximately 10 generations) (USFWS, 2023).

**Recovery Actions:**

- Work with partner biologists, state agencies, non-governmental conservation organizations, and private landowners to obtain protection for populations on privately owned lands (USFWS, 2023).
- Work with roadside rights-of-way stakeholders to develop and implement management agreements (USFWS, 2023).
- Develop and implement management plans for all populations (USFWS, 2023).
- Work with partners and stakeholders to develop and implement a monitoring strategy for all populations (USFWS, 2023).
- Increase the representation and genetic diversity of ex situ (off-site) safeguarding collections of fleshy-fruit gladecress (USFWS, 2023).
- Continue to facilitate and support surveys to identify new populations (USFWS, 2023).
- Conduct research that enhances knowledge of fleshy-fruit gladecress to facilitate the development of scientifically sound management plans, population viability models, and species/habitat distribution models (USFWS, 2023).
- Augment protected populations that are unable to grow in response to habitat management due to low population size and/or establish populations in suitable, but unoccupied, managed habitat on conservation lands (USFWS, 2023).
- Continue to coordinate with federal, state, county, and local agencies, private landowners, and other stakeholders to promote fleshy-fruit gladecress recovery and identify innovative ways to increase public awareness of the need to protect this species and its habitats (USFWS 2023).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS We will prepare a recovery plan for Leavenworthia crassa that includes objective and measurable criteria which, when met, will ensure the conservation of the species. Recovery criteria will address all meaningful threats to the species, as well as estimate the time and the cost to achieve recovery. The priority need is to address habitat-directed recovery actions. Viability of fleshy-fruit gladecress depends on protecting occurrences and suitable habitat from further degradation and fragmentation; restoring potentially suitable habitat within its historical range; evaluating and reducing threats from incompatible land uses, shading, and nonnative plants; increasing the size of current populations; conserving genetic diversity; and potentially establishing populations where suitable conditions are present on protected lands. The core actions include monitoring and protecting existing populations, long term conservation easements to protect existing populations (though the likelihood of landowner participation is uncertain), restoration of habitat through removal of woody invasive species (i.e., cedar and privet), and education and outreach. Detailed actions for fleshy-fruit gladecress conservation include: • Encourage landowner partnerships and proactive management with best management practices for species protection. Potential habitat protection mechanisms with landowners include fee simple purchase, conservation easement, or establishing a conservation agreement to ensure habitat receives necessary management and is protected from incompatible land uses. • Develop agreements with Departments of Transportation, railroad authorities, and transmission line companies to ensure population protection extends onto rights-of-ways in the species range to address issues such as invasive nonnative species and proactively curb herbicide use and mowing during sensitive periods of the year. • Continue to support efforts by the U.S. Forest Service to protect and manage the Indian Tomb Hollow Glade population on Bankhead National Forest. • Encourage and support additional surveys for populations. • Establish methods to effectively monitor, and if necessary, develop a captive propagation and reintroduction program for fleshy-fruit gladecress. • Initiate regular monitoring at each site, to include counts from discrete clusters, where possible. Monitoring should include periodic checks of viability and germination rates in order to evaluate whether diminished reproductive fitness poses a long-term threat to populations. • Determine the number of populations required to recover fleshy-fruit gladecress – i.e., to reduce the risk of extinction to the point that the species is no longer threatened or endangered. • Continue to coordinate with federal, state, county agencies, and non-governmental conservation agencies to promote plant recovery and find innovative ways to increase public awareness of the need to protect this species and its habitat. • Initiate public education efforts and direct contact with landowners to inform the public about the species and its habitat, and opportunities to participate in conservation efforts. • Work with partners to study missing data related to the species biology and life history to support understanding of species resiliency, representation, and redundancy, including: o Length of seed dormancy in soil and implications of potential seed banking. o Understanding the impact of increasing levels of self-fertilization in light of pollinator declines. o Conditions and techniques in a propagation and reintroduction plan to inform a captive propagation program. o Determination of the mating systems of populations that are currently unknown and/or confirm the presence of two mating systems in a population (USFWS, 2020)

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# SPECIES ACCOUNT: *Leavenworthia exigua laciniata* (Kentucky gladecress)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 06/05/2014; Southeast Region (Region 4) (USFWS, 2016)

**Physical Description**

A winter annual. Plants are about 5 to 10 cm (1.97 to 3.94 in) in height with early leaves that are simple with a slender petiole (central stalk of the leaf) and mature leaves that are sharply lobed (appear as disconnected pieces along the main leaf vein), somewhat squarish at the ends and arranged as a rosette (circular cluster of leaves) (Evans and Hannan 1990). The flowers are small (3 to 6 mm (0.12 to 0.24 in)), white to lilac in color with four petals, green rather than lavender sepals (the outer of two floral leaves that make up the flower), and leafless stems. Leaves typically disappear by the time the plant is in fruit (Evans and Hannan 1990). The fruit is flat and pod-shaped. Flowering begins in March, with seed dispersal occurring by mid-May. (USFWS, 2016; NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Kentucky: Bullitt and Jefferson counties. (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 5/6/2014.

**Legal Description**

On May 6, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Leavenworthia exigua laciniata (Kentucky glade cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Kentucky (79 FR 25689-25707).

**Critical Habitat Designation**

The critical habitat designation for Leavenworthia exigua laciniata includes six CHUs (sixteen sub-units) in Bullitt and Jefferson Counties, Kentucky. This species critical habitat encompasses approximately 2,053 acres (ac) (830 hectares (ha)) (79 FR 25689-25707).

Unit 1: McNeely Lake, Jefferson County, Kentucky: Unit 1 consists of 18 acres (ac) (7 hectares (ha)) within McNeely Lake Park in Jefferson County, Kentucky. This critical habitat unit is under county government ownership. This critical habitat unit occurs at the northwestern edge of the species' range, where there is little remaining habitat and few occurrences, and therefore this unit is important to the distribution of the species. Habitat degradation (e.g., erosion, invasive species) is impacting the species' ability to persist within this unit; however, the landowner has received funding and is working with the Service and KSNPC to develop a management plan for the site and to implement habitat improvement practices. These planned activities are expected to improve population numbers and viability at this important site. This unit helps to maintain the geographical range of the species and provides opportunity for population growth. Within Unit 1, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with encroachment by nonnative plants or forage species, and forest encroachment due to fire suppression.

Unit 2, Subunits A, B, and C: Old Mans Run, Jefferson and Bullitt Counties, Kentucky: Unit 2 consists of three subunits totaling 1,014 ac (410 ha) in Bullitt and Jefferson Counties, Kentucky. It is located just south of the Jefferson/Bullitt County line and extends north of Old Mans Run. This critical habitat unit includes four element occurrences. Subunit 2B represents the best remaining populations and habitat for L. exigua var. laciniata in Jefferson County. Subunits 2A and 2C are important areas at the northern extent of the species' range. These three subunits represent the northeastern extent of the population's range and increase population redundancy within the species' range. The features essential to the conservation of the species in Unit 2 may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment. Subunit 2A is 102 ac (41 ha) in size and is located west of US 150 and northwest of Floyds Fork. It is in private ownership. While all PCEs are present within this subunit, it contains few native plant associates for L. exigua var. laciniata, and the increased competition from lawn grasses may decrease the ability of L. exigua var. laciniata to persist. This subunit is important for maintaining the northern distribution of L. exigua var. laciniata. Subunit 2B is 870 ac (352 ha) in size and is located east of US 150 and extends north and south of Old Mans Run. It is in private ownership. This is the largest of the subunits and contains the two highest ranked (1–B and 1–C) occurrences in Jefferson County. It represents the best remaining habitat in this portion of the range and may contain more than half of the total L. exigua var. laciniata population based on a 2011 survey by KSNPC, which estimated more than 20,000 individuals at 4 sites within this subunit. In this subunit, competition from lawn grasses impacts L. exigua var. laciniata and may decrease the plant's ability to persist. Subunit 2C is 42 ac (17 ha) in size and is located west of US 150 and east of Floyds Fork, extending into both Bullitt and Jefferson Counties. It is in private ownership. This subunit is primarily pasture, and habitat for L. exigua var. laciniata is impacted by competition from lawn grasses. Habitat management within this subunit to improve habitat for L. exigua var. laciniata is important for maintaining the northern distribution of the species.

Unit 3, Subunits A, B and C: Mount Washington, Bullitt County, Kentucky: Unit 3 consists of 42 ac (17 ha) and includes three subunits in Bullitt County, Kentucky, primarily within or adjacent to the city limits of Mount Washington. This critical habitat unit includes three element occurrences and provides an important link between the northern and southern portions of the species' range. Within Unit 3, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 3A is 25 ac (10 ha) in size and is located northeast of Mount Washington. It is in private ownership. Habitat for L. exigua var. laciniata within this subunit is degraded and would improve with management. It represents important habitat on the eastern extent of the species' range. In this subunit, habitat conversion and ORV use impact L. exigua var. laciniata habitat and may decrease the species' ability to persist at this site. Subunit 3B is 7 ac (3 ha) in size and is located east of Hubbard Lane and south of Keeneland Drive. It is in private ownership. The glade habitat has been degraded by adjacent land use and would benefit from improved management. The subunit represents an important link between other subunits. Subunit 3C is 10 ac (4 ha) in size and is located east of US 150 and south of Highway 44E. It is in private ownership. The subunit represents an important and high quality cedar glade in an area of ongoing, intensive development. Land use surrounding the glade remnant appears stable and the glade contains several native plant species associated with L. exigua var. laciniata.

Unit 4, Subunits A, B, C, D, E, F, G, and H: Cedar Creek, Bullitt County, Kentucky: Unit 4 consists of 547 ac (221 ha) and includes eight subunits, all in Bullitt County, Kentucky. This unit is located south of the Salt River and northeast of Cedar Grove and seems to represent the core of the remaining high-quality habitat for L. exigua var. laciniata. It includes eight element occurrences. In addition to being a stronghold for the species, these subunits are generally within close proximity (less than 0.5 miles (0.8 km)) to each other and represent the best opportunity for genetic exchange between occurrences. Within Unit 4, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 4A is 91 ac (37 ha) in size and is located south of Cedar Creek and west of Pine Creek Trail. This subunit is owned by The Nature Conservancy and encompasses most of the Pine Creek Barrens Preserve. This excellent-quality glade represents the only remaining ‘‘A’’ rank occurrence for L. exigua var. laciniata. Subunit 4B is 69 ac (28 ha) in size and is located along an unnamed tributary to Cedar Creek, and south of KY 1442. This good-quality glade includes the Apple Valley Glade State Nature Preserve, owned by KSNPC (approximately 30 percent of subunit), as well as private land, including some under permanent conservation easement (approximately 41 percent of subunit) to protect L. exigua var. laciniata. Approximately 29 percent of this subunit is under private ownership without any protections for L. exigua var. laciniata. Subunit 4C is 83 ac (34 ha) in size and located north of Cedar Creek and south of Apple Valley State Nature Preserve. It is in private ownership. This subunit contains high-quality glades with a community of native plants present. Subunit 4D is 46 ac (19 ha) in size and is located north of Cedar Creek and south of Victory Church. It is in private ownership. This subunit has been degraded and would benefit from improved management. Native plants associated with L. exigua var. laciniata occur within this subunit, but competition from lawn grasses, as well as forest encroachment due to fire suppression, impacts L. exigua var. laciniata and may decrease its ability to persist. Subunit 4E is 102 ac (41 ha) in size and is located southeast of subunit 4D and across Cedar Creek. It is in private ownership. It contains a large number of L. exigua var. laciniata (several thousand), but the habitat has been degraded by adjacent land use and would benefit from improved management. Competition from lawn grasses, as well as forest encroachment due to fire suppression, affects L. exigua var. laciniata and may decrease the plant’s ability to persist. Subunit 4F is 120 ac (49 ha) in size and is south of the confluence of Cedar Creek and Greens Branch. It is in private ownership. This is a degraded glade that still contains native plants associated with L. exigua var. laciniata. The subunit is disturbed by existing and surrounding land uses, as well as utility line maintenance and ORV use, which may decrease the species’ ability to persist. Subunit 4G is 20 ac (8 ha) in size and is located along either site of KY 480 near White Run Road. It is in private ownership. This site contains a large number of plants; however, improved habitat conditions are needed for longterm viability of the L. exigua var. laciniata occurrence. Impacts to L. exigua var. laciniata, which may decrease its ability to persist at this site, include incompatible agricultural or grazing practices, ORV use, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 4H is 16 ac (6 ha) in size and is located 0.95 miles southeast of the KY 480/KY 1604 intersection. It is in private ownership. Within this subunit, several patches of good habitat for L. exigua var. laciniata remain as well as a good diversity of native plant associates. However, competition from lawn grasses, as well as forest encroachment due to fire suppression, affects L. exigua var. laciniata and may decrease its ability to persist.

Unit 5, Subunits A and B: Cox Creek, Bullitt County, Kentucky: Unit 5 consists of 58 ac (23 ha) and includes two subunits, both in Bullitt County, Kentucky. It includes two element occurrences, representing the most easterly occurrences south of the Salt River. These subunits are important for maintaining the distribution and genetic diversity of the species. Within Unit 5, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with illegal waste dumps, development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 5A is 8 ac (3 ha) in size and is located east of Cox Creek and west of KY 1442. It is in private ownership. This site is threatened by ORV use and would benefit from improved habitat management. Subunit 5B is 50 ac (20 ha) in size and is located west of Cox Creek near the Bullitt/Spencer County line. It is in private ownership. Incompatible agricultural practices and ORV use impacts L. exigua var. laciniata and may decrease its ability to persist. The native flora is mostly intact, and L. exigua var. laciniata would benefit from improved habitat management.

Unit 6: Rocky Run, Bullitt County, Kentucky: Unit 6 consists of 374 ac (151 ha) in Bullitt County, Kentucky. This critical habitat unit includes habitat that is under private ownership, including one 16-acre registered natural area. It includes one element occurrence. This unit appears to represent the largest intact glade habitat remaining within the range of the species. Within Unit 6, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, competition from lawn grasses, and forest encroachment due to fire suppression.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Leavenworthia exigua laciniata critical habitat consists of two components (79 FR 25689-25707):

(i) Cedar glades and gladelike areas within the range of L. exigua var. laciniata that include: (A) Areas of rock outcrop, gravel, flagstone of Silurian dolomite or dolomitic limestone, and/or shallow (1 to 5 centimeters (0.393 to 1.97 inches)), calcareous soils; (B) Intact cyclic hydrologic regime involving saturation and/or inundation of the area in winter and early spring, then drying quickly in the summer; (C) Full or nearly full sunlight; and (D) An undisturbed seed bank.

(ii) Vegetated land around glades and gladelike areas that extends up and down slope and ends at natural (e.g., stream, topographic contours) or manmade breaks (e.g., roads).

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Threats to those features that define primary constituent elements for L. exigua var.

laciniata include (but are not limited to): (1) Residential and commercial development on private land; (2) construction and maintenance of roads and utility lines; (3) incompatible agricultural or grazing practices; (4) off-road vehicle (ORV) use or horseback riding; (5) encroachment by nonnative plants or forage species; and (6) forest encroachment due to fire suppression. These threats are in addition to random effects of droughts, floods, or other natural phenomena. Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could address these threats include (but are not limited to): (1) Avoiding cedar glades (or suitable gladelike habitats) when planning the location of buildings, lawns, roads (including horse or ORV trails), or utilities; (2) avoiding aboveground construction and/or excavations in locations that would interfere with natural water movement to suitable habitat sites; (3) protecting and restoring as many glade complexes as possible; (4) research supporting the development of management recommendations for grazing and other agricultural practices; (5) technical or financial assistance to landowners that may help in the design and implementation of management actions that protect the plant and its habitat; (6) avoiding lawn grass or tree plantings near glades; and (7) habitat management, such as brush removal, prescribed fire, and/or eradication of lawn grasses to maintain an intact native glade vegetation community.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 2016)

**Breeding Season**

Adult: Begins in March (USFWS, 2016)

**Reproduction Narrative**

Adult: A winter annual. L. exigua var. laciniata persist through the winter as rosettes, and flowering begins in late February to early March (Baskin and Baskin 1981; Evans and Hannan 1990). Seeds are set and plants die in April and May as the glade habitats dry out (Baskin and Baskin 1985; Solbrig 1971). At maturity, most of these seeds are dormant and will not germinate following dispersal, even if the soils are moist (Baskin and Baskin 1985). During the summer, these seeds undergo physical changes known as after-ripening and move from dormancy to conditional dormancy and finally, become non-dormant for fall germination (Baskin and Baskin 1985). (USFWS, 2016)

**Habitat Type**

Adult: Terrestrial (USFWS, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Cedar glades (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: Shade intolerant and prefers sparse vegetation (USFWS, 2016)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 2016)

**Habitat Narrative**

Adult: L. exigua var. laciniata appears to be adapted to environments with shallow soils interspersed with flat-bedded, Silurian dolomite and dolomitic limestones, which is an uncommon geological formation in Kentucky (Rollins 1963; Evans and Hannan 1990). The soil on these horizontally bedded limestone areas is often only a few inches in depth or may be completely lacking in some areas (Rollins 1963). Because of the thin soils and underlying limestones, these habitats, called cedar or limestone glades, are extremely wet from late winter to early spring and quickly become dry in May and June. The natural habitat for L. exigua var. laciniata is these cedar glades (Baskin and Baskin 1981), but the taxon is also known from overgrazed pastures, eroded shallow soil areas with exposed bedrock, and areas where the soil has been scraped off the underlying bedrock (Evans and Hannan 1990). L. exigua var. laciniata does not appear to compete well with other vegetation and is shade intolerant (Evans and Hannan 1990) (USFWS, 2016).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Short-term trends suggest declines of 10-50% (NatureServe, 2015)

**Number of Populations:**

77 (USFWS, 2020)

**Population Size:**

1000 - 100,000 individuals (NatureServe, 2015)

**Population Narrative:**

The Kentucky glade cress is endemic to a portion of Jefferson and Bullitt counties, Kentucky and is currently known to occur in 77 extant populations. After the taxon was listed as threatened in 2014, 12 new populations have been found. More than half of the known extant occurrences are considered to have poor resiliency. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The greatest threat to Leavenworthia exigua var. laciniata is the destruction and degradation of glades through development, roads, utilities, and conversion to lawns. Documented impacts from horseback riding, off-road vehicle use, and changes in grazing practices have resulted in the loss or degradation of several L. exigua var. laciniata occurrences.

These activities are expected to continue in the future but to an unknown extent. Forest encroachment is expected to continue in areas without active management. Climate change has the potential to impact this species, but to what extent cannoted be predicted (USFWS, 2014).

**Stressor:** Narrow range and small populations (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Leavenworthia exigua var. laciniata has a narrow range, occurring in only small portions of two counties. Within this range, L. exigua var. laciniata is restricted to cedar glades and similar shallow-soiled areas that occur sporadically across the range. More than half of the remaining occurrences had low (fewer than 100 individuals) population counts at the time of the most recent survey. Additionally, the presumed low genetic diversity within individual occurrences of L. exigua var. laciniata could place those occurrences at a high risk of extirpation as their capacity for adaptation to change is reduced (USFWS, 2014).

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 9

**Delisting Criteria:**
Criterion 1. At least 40 Kentucky Glade Cress populations1 , distributed across its range, exhibit a stable or increasing trend over 10 years of monitoring (Factors A and E). Criterion 2. At least 20 of the populations from Criterion 1 occur on natural or restored high-quality glade habitat and have 1,000 or more plants during 5 of the past 10 years of monitoring. Criterion 3. All of the populations in Criterion 1 are permanently protected and managed under an agreement such that threats are abated to the extent to ensure population viability for the foreseeable future. (USFWS, 2022)

**Recovery Actions:**

- 1. Permanently protect Kentucky Glade Cress populations and immediate surrounding habitat from destruction and degradation by development, with an emphasis on those in designated critical habitat and other areas of high-quality glade habitat. Estimated Cost $17,000,000 . 2. Conduct routine monitoring of Kentucky Glade Cress populations. Estimated Cost: $100,000. 3. Implement management activities to restore degraded glades and maintain high-quality glades that contain Kentucky Glade Cress populations. Estimated Cost: $50,000. 4. Encourage measures to avoid Kentucky Glade Cress patches in proposed developments. 5. Foster public appreciation for Kentucky Glade Cress and glade habitat through public outreach within and in the vicinity of its range. Estimated Cost: $15,000. 6. Research the biology of Kentucky Glade Cress. Estimated Cost: $259,000. 7. Reintroduce or introduce populations in suitable habitat within the taxon’s range. Estimated Cost: $10,000 (USFWS, 2022)
- Conservation measures are not available.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recovery actions should be made a priority over the next 5 years: 1. Complete a recovery plan. 2. Continued public outreach to provide education on the species and its habitat and to explore opportunities for conservation on private property. 3. Look for opportunities to protect existing populations through voluntary conservation easements or other voluntary mechanisms. 4. Develop and implement management strategies for the taxon and its habitat. 5. Develop a program to monitor trends in population resiliency. 6. Establish methods and a plan to effectively reintroduce or introduce the taxon into suitable habitat within its range. 7. Enhance the suitability of known sites and potential reintroduction sites. 8. Define population regulation factors. (USFWS, 2020)

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# SPECIES ACCOUNT: *Leavenworthia texana* (Texas golden Gladecress)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/11/2013; Southwest Region (Region 2)

**Physical Description**

A weakly rooted, glabrous (smooth, glossy), winter annual (completes its life cycle in 1 year). Texas golden gladecress is small in stature, less than 3.9 inches (in) (10 centimeters (cm)) in height, making it difficult to find except during flowering or when it bears fruit. The leaves are 0.8-3.1 in (2-8 cm) long and 0.4-0.6 in (1-1.5 millimeters (mm)) wide, forming rosettes at the base of the plant. Terminal leaf segments are wider-than-long, and usually distinctly lobed, with angular teeth. Flowers are bright yellow and borne on scapes (leafless flowering stems or stalks arising from the ground) that are 1.2-3.5 in (3-9 cm) long early in the flowering season. Later in the season, the flowers occur on unbranched flower clusters that come off a single central stem from which the individual flowers grow on small stalks, at intervals. The four petals are bright golden-yellow with a slightly darker base, narrowly obovate (tongue-shaped), 0.3-0.4 in (7-10 mm) long and 0.1-0.2 (3.5-5 mm) wide. The fruit is a slender seed capsule, known as a silique, with a length (0.6-1.2 in (15-30 mm)) that is more than twice its width (0.08-0.22 in (2-5.5 mm)) and that contains 5 to 11 flattened, circular or spherically shaped seeds. (USFWS, 2013a)

**Taxonomy**

In the mustard family (Brassicaceae). Dr. M. C. Leavenworth, an Army physician, first collected the taxon in Choctaw County, Oklahoma, in 1835, and the specimens were later described as a new species, Leavenworthia aurea, by Torrey (Mahler 1981, pp. 76-77). From 1836 to 1837, Leavenworth collected similar specimens near the present-day town of San Augustine, San Augustine County, Texas, and these were also identified as L. aurea. E. J. Palmer (1915 and 1918), and D. S. and H. B. Correll (1961 to 1962) as cited by Mahler (1981, pp. 83) made later collections of the plant in the San Augustine area. George and Nixon (1990, pp. 117-127) studied and mapped populations in this area between 1979 and 1980. W. H. Mahler studied the collected specimens and their habitat, and described the Texas plants as a new species, Leavenworthia texana (Mahler 1987, pp. 239-242), based on differences in morphological characteristics of flowers and leaves, and in chromosome number, between the Oklahoma and Texas plants (Mahler 1987, pp. 239-242). According to Mahler (1987, p. 240), Texas golden gladecress flower petals were a brighter, deeper yellow than those of L. aurea, and the petals were egg-shaped and flat instead of being broad and notched. The L. texana had wider-than-long terminal leaf segments that were usually distinctly lobed while L. aurea' s terminal leaves were essentially unlobed, flat, and more circular. Texas plants had a chromosome number of 2n = 22 (Nixon 1987, pers. comm. in Mahler 1987, pp. 239, 241) while the Oklahoma L. aurea had 2n = 48 (Rollins 1963, pp. 9-11; Beck et al. 2006, p. 156). We are aware that a recently completed monograph of the genus may have taxonomic implications for the Texas and Oklahoma Leavenworthia species in the future, but several questions, including the differences in chromosome number, remain unresolved and no supporting information that would change the current status of Texas golden gladecress has been published to date (Poole 2011a, pers. comm.). (USFWS, 2013a)

**Historical Range**

Texas golden gladecress is known from eight locations (historic and extant), including one introduced population, all within a narrow zone that parallels SH 21 in San Augustine, Sabine, and Nacogdoches Counties (Texas Natural Diversity Database (TXNDD) 2012b). (USFWS, 2013a)

**Current Range**

San Augustine and Sabine Counties in eastern Texas, on a particular geologic formation (the Weches Formation). (USFWS, 2013a)

**Critical Habitat Designated**

Yes; 10/11/2013.

**Legal Description**

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for Leavenworthia texana (Texas golden Gladecress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Sabine and San Augustine Counties, Texas. (USFWS, 2013b)

**Critical Habitat Designation**

The critical habitat designation for Leavenworthia texana includes four CHUs in Sabine and San Augustine Counties, Texas. This species critical habitat encompasses approximately 1,353 acres (ac) (548 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule. (USFWS, 2013b)

Unit 1: Geneva: Unit 1 consists of 388 ac (157 ha) of private and State land located in northwest Sabine County, Texas. The unit is located 1.5 mi (2.3 km) south of Geneva, Texas, and 4.8 mi (7.7 km) north of Milam, Texas, and is bisected by SH 21.

Unit 2: Chapel Hill: Unit 2 consists of 150 ac (61 ha) of privately owned land, with one county road ROW, in northwestern San Augustine County, Texas. This unit is located 1.0 mi (1.6 km) south of SH 21, due west of the San Augustine-Sabine County line, and lies alongside County Road (CR) 151. This unit is linear in shape, running from southeast to northwest. Aside from CR 151, all other land in Unit 2 is privately owned. Current land cover appears to be approximately 70 percent woody cover; much of the forest being rows of pine trees.

Unit 3: Southeast Caney Creek Glades: Unit 3 consists of 39.9 ac (16.2 ha) just southeast of the City of San Augustine, San Augustine County, Texas. Approximately 99 percent of the land within this unit is privately owned, with the other 1 percent being county ROW under the management of TXDOT. This unit is located 0.8 mi (1.2 km) south from SH 21 near San Augustine, Texas, along the north side of FM 3483. This unit is located across Sunrise Road from a glauconite quarry.

Unit 4: Northwest Caney Creek Glades: Unit 4 consists of 775.3 ac (313.7 ha) that extends in a diagonal line from northeast to southwest, to the north and south of SH 21 just east of the City of San Augustine, San Augustine County, Texas. The unit is approximately 0.7 mi (1.1 km) wide.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Leavenworthia texana critical habitat consists of three components (USFWS, 2013b):

(i) Exposed outcrops of the Weches Formation within Weches prairies. Within the outcrop sites, there must be bare, exposed bedrock on top-level surfaces or rocky ledges with small depressions where rainwater or seepage can collect. The openings should support Weches Glade native herbaceous plant communities.

(ii) Thin layers of rocky, alkaline soils, underlain by glauconite clay (greenstone, ironstone, bluestone), that are found only on the Weches Formation. Appropriate soils are in the series classifications Nacogdoches clay loam, Trawick gravelly clay loam, or Bub clay loam, ranging in slope from 1– 15 percent.

(iii) The outcrop ledges should occur within the glade such that Texas golden gladecress plants remain unshaded for a significant portion of the day, and trees should be far enough away from the outcrop(s) that leaves do not accumulate within the gladecress habitat. The habitat should be relatively clear of nonnative and native invasive plants, especially woody species, or with only a minimal level of invasion.

**Special Management Considerations or Protections**

Texas golden gladecress may require special management considerations or protection to reduce the following threats: quarrying or other excavations, including pipeline installations; building over the top of occupied glades; construction or excavation upslope that alters water movement (sheet flow or seepage) downslope to Texas golden gladecress sites; pine tree plantings near glades; and invasive (native and nonnative) plants. Refer to the five-factor analysis in the listing determination for the Texas golden gladecress for more information on these threats. The features essential to the conservation of Texas golden gladecress may require special management considerations or protection to reduce the following threats: • Actions that remove the soils and alter the surface geology of the glades; • Building or paving over the glades; • Construction or excavation upslope that alters water movement (sheet flow or seepage) downslope to Texas golden gladecress sites; • Planting trees adjacent to the edges of an outcrop resulting in shading of the glade and accumulations of leaf litter and tree debris; • Encroachment by nonnative and native invading trees, shrubs, and vines that shade the glade; • The use and timing of application of certain herbicides that can harm Texas golden gladecress mature plants and seedlings; and • Fence placement such that livestock are likely to be directed through gladecress sites where habitat and plants may be trampled. Management activities that could ameliorate these threats include (but are not limited to): • Avoiding Weches glades when planning the location of quarries, well pads, roads, other facilities or structures, or pipeline routes, through glade complexes; • Avoiding above-ground construction or excavations in locations that would interfere with natural water movement to Texas golden gladecress habitat sites; • Locating suitable habitat and determining the presence or absence of the species and identifying areas with glade complexes and protecting or restoring as many complexes as possible; • Extending outreach to all landowners, including private and State, to raise awareness of the plant and its specialized habitat; • Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; • Avoiding pine tree plantings near glades; and • Brush removal, to maintain an intact native glade vegetation community. (USFWS, 2013b)

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: March to April (NatureServe, 2015)

**Reproduction Narrative**

Adult: A winter annual, 2-10 cm tall, that produces bright yellow flowers in March and April. (NatureServe, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Wet glades, herbaceous communities (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Vernally wet environment (NatureServe, 2015)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Herbaceous communities in vernally wet glades with shallow, calcareous soils on Weches Formation ironstone outcrops. Associated species include the rare white bladderpod (Lesquerella pallida), as well as flat stemmed spike-rush (Eleocharis compressa), and rock stonecrop (Sedum pulchellum). (NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Long-term trends indicate a decline of 30-70%, whereas short-term trends suggest a decline of 30-50% (NatureServe, 2015)

**Number of Populations:**

4 (USFWS, 2024)

**Population Size:**

250 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

Long-term population trends indicate a decline of 30-70%, whereas short-term trends suggest a decline of 30-50%. The small population size and low number of sites make this taxon vulnerable to effects of stochastic phenomena and catastrophic events; it has very low numbers in drought years (USFWS, 2004). At least two historical sites have been lost due to glauconite mining (USFWS 2012). Numbers of (growing) plants vary somewhat year-to-year. In 2009, the three extant sites had 98, 29, and 260 plants respectively (USFWS 2012). Three natural occurrences with intact habitat as of 2011 (USFWS 2012). An introduced site had plants through 2009 but a 2011 survey found the plants had been removed by a pipeline installation (USFWS 2012). Seed banks may persist at two historical sites (USFWS 2012). (NatureServe, 2015). The Texas golden gladecress is an annual plant and member of the family Brassicaceae. The best available information suggests that 4 extant populations occur in Texas on private and state-owned lands within San Augustine, Sabine, and Nacogdoches counties, Texas. Three of these populations are natural, and 1 introduced (Nacogdoches County). These populations are represented by Texas Parks and Wildlife Department's Element of Occurrence (EO) IDs from the Texas Natural Diversity Database (TXNDD; 2020, pp. 1-18. These populations are distributed across the Weches geologic formation that loosely parallels Texas State Highway 21 within these counties (Figure 1). Sites are relatively bare (treeless) and host a diverse set of associated species that vary throughout the annual cycle of the Texas golden gladecress. The species depends on cool, wet winter months to aid in its growth, promoting a short flowering season in February and March each year. When temperatures warm in summer, Texas golden gladecress withers away, and drought-tolerant species emerge. Glade exposures on the Weches geology are naturally small, giving rise to smaller population sizes, and therefore increasing the species' chances of negative effects from stochastic events. Due to its annual nature, plant numbers fluctuate each year. Little is known about the species' seed biology, reproductive strategies (i.e., need of pollinators), and/or genetic relatedness among and within populations. Known threats to the species include habitat loss, modification, degradation; climate change; and ineffective management strategies (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The most significant threat to habitat of Texas golden gladecress is surface quarrying of glauconite and the exploration and development of oil and natural gas wells and associated roads and pipelines have destroyed 50 percent of the known populations between the mid-1990s and 2011. In addition, excavations may occur when pipelines for water, sewer lines, gas connections to homes, and communication lines are installed may damage populations and habitat. Texas golden gladecress also faces threats throughout its range from competition for light and nutrients from both native and nonnative, invasive, woody plants, including the nonnative Macartney rose. Additionally, herbicides used to control Macartney rose may be a threat to the Texas golden gladecress if applied to or persisting in the soil during the species' period of growth, from late fall through early summer. A recent, ongoing trend in local land use is the conversion of open pasture to pine plantations. However, densely planted pine trees may degrade the species' habitat due to competition for light and nutrients and by contributing masses of leaf litter onto formerly sparsely vegetated glades. Finally, the information regarding climate change is not yet specific enough for us to determine the potential long-term effects to the Texas golden gladecress's habitat. However, long-term drought has negatively affected and will likely continue to negatively affect the reproduction and germination of Texas golden gladecress seeds (USFWS, 2013).

**Stressor:** Small populations (USFWS, 2013a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Texas golden gladecress is a historically rare species with some adaptations, such as a mixed mating system, that help to alleviate part of the inherent risks of small population size. The continued existence of Texas golden gladecress is negatively impacted by natural factors including being limited to only a few remaining populations that contain very small numbers of individual plants with a distribution restricted to extremely small areas of outcrop. The species' current, reduced occurrences across a range that has been highly fragmented by past and ongoing human activities increase its vulnerability. With only three remaining populations, loss of an entire population could be catastrophic for this species' long-term viability. Therefore, the small number of remaining populations, all of which are small in size, in conjunction with the threats to habitat, constitutes a threat to the species and greatly exacerbates other the threats identified for this species (USFWS, 2013a).

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 5

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Recovery actions are not available.
- Conservation measures are not available.

**References**

USFWS. 2013a. Determination of Endangered Status for Texas Golden Gladecress and Threatened Status for Neches River Rose-Mallow

Final Rule. 78 FR 56025 – 56069 (September 11, 2013).

USFWS. 2013b. Designation of Critical Habitat for Texas Golden Gladecress and Neches River Rose-Mallow. Final Rule. 78 FR 56072-56120 (September 11, 2013).

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

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USFWS. 2013a. Determination of Endangered Status for Texas Golden Gladecress and Threatened Status for Neches River Rose-Mallow

Final Rule. 78 FR 56026 - 56069 (September 11, 2013).

# SPECIES ACCOUNT: *Lepidium papilliferum* (Slickspot peppergrass)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 09/16/2016; Pacific Region (R1)

**Physical Description**

An intricately branched, tap-rooted plant, averaging 2 to 8 in. tall, but occasionally reaching up to 16 in. tall. Leaves and stems are covered with fine, soft hairs, and the leaves are divided into linear segments. Flowers are numerous, 0.11 to 0.15 in. in diameter, white, and four-petalled. Fruits (silicles, which are seed capsules that are less than twice as long as they are wide) are 0.10 to 0.15 in. wide, round in outline, flattened, and twoseeded (Moseley 1994, pp. 3, 4; Holmgren et al. 2005, p. 260). (USFWS, 2020)

**Taxonomy**

Slickspot peppergrass is a member of the Mustard Family (Brassicaceae). . Louis Henderson originally described slickspot peppergrass as L. montanum var. papilliferum in 1900. It was renamed L. papilliferum by Aven Nelson and J. Francis Macbride in 1913 based on its distinctive growth habit, short lifespan, and unusual pubescence (Nelson and Macbride 1913, p. 474). Hitchcock regarded slickspot peppergrass as L. montanum var. papilliferum influencing several publications including Flora of Idaho and Flora of the Pacific Northwest (Davis 1952, p. 347; Hitchcock et al. 1964, p. 516; Hitchcock and Cronquist 1973, p. 170; Steele 1981, p. 55; Moseley 1994, p. 2). In a 1993 review of taxa in the mustard family (Brassicaceae), Reed Rollins maintained the species based on differences in the physical features between the slickspot peppergrass and L. montanum (mountain pepperweed): • Slickspot peppergrass has trichomes (hair-like structures) occurring on the filaments of stamens (part of flower that produces pollen), but mountain pepperweed does not; • All the leaves on slickspot peppergrass are pinnately divided whereas mountain pepperweed has some leaves that are not divided; • The shape of the silicle [silique] (seed capsule) of slickspot peppergrass is different from that of mountain pepperweed; and • The silicle of slickspot peppergrass has no wings, or even vestiges of wings, at its apex (end of the capsule), unlike that of mountain pepperweed (Rollins 1993, p. 578; Moseley 1994, p. 2). Common names for this plant include slickspot peppergrass (Holmgren et al. 2005, p. 259), slick spot peppergrass (Moseley 1994, p. 1), and Idaho pepperweed (ITIS 2018, p. 1). The common name refers to its typical habitat—in or near slick spot microsites, and the peppery taste of the seeds. 'Grass' is a misnomer, and most members of the genus Lepidium are referred to as peppercress, pepperweed, or pepperwort (IDFG in litt. 2018, p. 2). Throughout this SSA, we refer to the species as slickspot peppergrass. (USFWS, 2020)

**Historical Range**

Historical extent is unknown. (USFWS, 2020)

**Current Range**

Slickspot peppergrass occurs only in southwestern Idaho in Ada, Canyon, Gem, Elmore, Payette, and Owyhee counties. This species is from three geographic areas based on landform: the Foothills geographic area, the Snake River Plain geographic area, and the Jarbidge geographic area. (USFWS, 2020)

**Critical Habitat Designated**

Yes; 6/5/2023.

**Legal Description**
We, the U.S. Fish and Wildlife Service (Service or USFWS), finalize the designation of critical habitat for slickspot peppergrass (Lepidium papilliferum) under the Endangered Species Act of 1973 as amended (Act). In total, approximately 31,569 hectares (78,009 acres) in Ada, Elmore, Gem, Payette, and Owyhee Counties in Idaho fall within the boundaries of the final critical habitat designation. The effect of this final rule is to designate critical habitat for the slickspot peppergrass, which is a threatened species under the Act.

**Critical Habitat Designation**

pilliferum (Slickspot Peppergrass) (1) Critical habitat units are depicted for Ada, Elmore, Gem, Owyhee, and Payette, Counties, Idaho

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the specific physical or biological features (PBFs) essential to the conservation of slickspot peppergrass consist of four components:

(i) Ecologically functional microsites or ‘‘slick spots’’ that are characterized by: (A) A high sodium and clay content, and a three-layer soil profile, which allows for successful seed germination, seedling growth, and maintenance of the seed bank. The surface horizon consists of a thin, silty vesicular, pored (small cavity) layer that forms a physical crust (the silt layer). The subsoil horizon is a restrictive clay layer, with an abruptic (referring to an abrupt change in texture) boundary with the surface layer, that is natric or natric-like in properties (a type of argillic (clay-based) horizon with distinct structural and chemical features); this is the restrictive layer. The second argillic subsoil layer (that is less distinct than the upper argillic horizon) retains moisture through part of the year (the moist clay layer). (B) Sparse vegetation, with invasive, nonnative plant species cover absent or limited to low to moderate levels.

(ii) Relatively intact, native Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis) vegetation assemblages, represented by native bunchgrasses, shrubs, and forbs, within 500 m (1,640 ft) of slickspot peppergrass element occurrences to protect slick spots and slickspot peppergrass from disturbance from wildfire, slow the invasion of slick spots by nonnative plant species and native harvester ants, and provide the habitats needed by slickspot peppergrass' pollinators.

(iii) A diversity of native plants whose blooming times overlap to provide pollinator species with flowers for foraging throughout the seasons and to provide nesting and egg-laying sites; appropriate nesting materials; and sheltered, undisturbed places for hibernation and overwintering of pollinator species. In order for genetic exchange of slickspot peppergrass to occur, pollinators must be able to move freely between slick spots. Alternative pollen and nectar sources (other plant species within the surrounding sagebrush vegetation) are needed to support pollinators during times when slickspot peppergrass is not flowering, when distances between slick spots are long, and in years when slickspot peppergrass is not a prolific flowerer.

(iv) Sufficient pollinators for successful fruit and seed production, particularly pollinator species of the sphecid and vespid wasp families, species of the bombyliid and tachnid fly families, and halictid bee species, most of which are solitary insects that nest outside of slick spots in the surrounding sagebrush-steppe vegetation, both in the ground and within the vegetation.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. A detailed discussion of the threats affecting the PBFs essential to the conservation of slickspot peppergrass, and that may require special management consideration or protection, can be found in the final listing rule published in the Federal Register on October 8, 2009 (74 FR 52014), the 2016 final rule reinstating threatened status for the species under the Act (81 FR 55058, August 17, 2016), in the recently completed SSA report (USFWS 2020, pp. 59–83, 85–103), and in the latest 5- year review (USFWS 2021). The primary threats to the PBFs for slickspot peppergrass include the following direct and indirect effects: the current wildfire regime (i.e., increasing frequency, size, and duration), invasive, nonnative plant species (e.g., cheatgrass), and habitat loss and fragmentation due to agricultural and urban development. One of the indirect threats experienced by slickspot peppergrass is the negative impact on insect pollinators caused by conversion and fragmentation of native habitats due to invasive, nonnative plant species and various forms of development. Another indirect threat is the potential increase in seed predation by Owyhee harvester ants resulting from the conversion of sagebrush-steppe to grasslands. Livestock pose a threat to slickspot peppergrass, primarily through mechanical damage to individual plants and slick spot habitats; however, current livestock management conditions and associated conservation measures address this potential threat such that it does not pose a significant risk to the viability of the species as a whole. In the 2009 listing rule (74 FR 52014, October 8, 2009), climate change in and of itself was not considered to represent a significant range-wide threat to slickspot peppergrass; however, it was acknowledged that climate change potentially plays an important supporting role in intensifying the primary threats to the species. Information identified in the SSA (USFWS 2020, pp. 79–82) indicated that climate change has already amplified the effects of wildfire and invasive, nonnative plants on slickspot peppergrass, and through its influence on invasive, nonnative annual grass spread, climate change may have been a factor in the continuing downward trend in slickspot peppergrass population numbers observed over the past decade. Other, less significant factors that have the potential to impact the species include the effects from rangeland revegetation projects, wildfire management practices, recreation, and military use. All areas of critical habitat may require some level of management to address current and future threats to slickspot peppergrass and to maintain or restore the PBFs. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the nearby plant community components. Rapid response to wildfires from local and government fire agencies can potentially limit the size of wildfires and the spread of wildfire into slickspot peppergrass habitat. For fires that do occur in critical habitat, post-fire restoration plans can identify ways to limit invasive, nonnative vegetation and restore habitat using native plants. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of invasive, nonnative unseeded plant species and seeded nonnative plants (also referred to as ‘‘highly competitive nonnative seeded plants’’ (USFWS 2020, p. 68)) may include the following: (1) protecting remnant blocks of native vegetation, (2) educating the public about invasive, nonnative species, (3) supporting research and funding for nonnative plant species control and native species restoration, (4) preventing or restricting the establishment of nonnative plant species, (5) washing vehicles prior to travel into areas containing slickspot peppergrass, and (6) reducing the likelihood of wildfires. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of livestock use may include conservation measures and actions to minimize the effects of livestock use on these lands. Existing conservation plans and land use plans contain numerous measures to avoid, mitigate, and monitor the effects of livestock use on slickspot peppergrass. For example, livestockgrazing conservation measures are implemented through the conservation agreement between the Bureau of Land Management (BLM) and the Service (BLM 2014, pp. 8–12) and the Mountain Home Air Force Base Integrated Natural Resources Management Plan (INRMP; U.S. Air Force 2017, p. 192). Existing conservation measures include prescribing a minimum distance for the placement of salt and water troughs, identifying livestock use restrictions to reduce trampling of slick spots during wet periods, constructing fences, or potentially modifying current livestock use. We recognize the potential for negative impacts to slickspot peppergrass populations and slick spots that may result from seasonal, localized trampling events. However, under current management conditions, we do not consider livestock use to pose a significant threat to slickspot peppergrass. We encourage the continued implementation of conservation measures and associated monitoring to ensure potential impacts of livestock trampling to slickspot peppergrass are avoided or minimized. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of residential and agricultural development may include the following: (1) creating managed plant reserves and open spaces, (2) limiting disturbances to and within suitable habitats, (3) increasing compliance inspections with livestock grazing permit holders, (4) requiring project fencing with adjacent construction activities, (5) disallowing new roads, and (6) evaluating the need for, and conducting, restoration efforts or revegetation of native plants in open spaces, plant preserves, or disturbed areas. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of Owyhee harvester ant seed predation are addressed under the special management considerations for the current wildfire regime and invasive nonnative plants. Finally, the protection of pollinators and their habitat is essential to the conservation of slickspot peppergrass. General pollinator management practices include: (1) maintaining a diversity of native plants with overlapping bloom times to provide flowers for foraging throughout the pollinators’ active season, (2) nesting and egg-laying sites (e.g., bare ground, hollow stems, bunchgrasses, and larval host plants), (3) sheltered, undisturbed places for overwintering, (4) a landscape free of pesticides and high levels of pathogens, and (5) connected habitat patches (The Xerces Society 2018, pp. 15–17). The designation of critical habitat does not imply that lands outside of critical habitat do not play an important role in the conservation of slickspot peppergrass. Activities with a Federal nexus that may affect those areas outside of critical habitat, such as development, agricultural, or road construction activities, are still subject to review under section 7 of the Act if they may affect slickspot peppergrass.

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Seed Production: Depending on an individual plant’s vigor, the effectiveness of its pollination, and whether it is functioning as an annual or a biennial, each slickspot peppergrass plant produces varying numbers of seeds (Quinney 1998, pp. 15, 17). Biennial plants normally produce many more seeds than annual plants (Meyer et al. 2005, p. 15). Average seed output for annual plants at the Idaho Army National Guard's (IDARNG) Orchard Combat Training Center (OCTC) was 125 seeds per plant in 1993 and 46 seeds per plant in 1994. In contrast, seed production of biennials at this site in 1993 and 1994 averaged 787 and 105 seeds per plant, respectively (Meyer et al. 2005, p. 16). Based on data collected from a 4-year demography study on the OCTC, survivorship of the annual form of slickspot peppergrass was demonstrated to be higher than survivorship of biennials (Meyer et al. 2005, p. 16). Meyer et al. (2005, p. 21) hypothesize that the reproductive strategy of slickspot peppergrass is a plastic response, meaning that larger plants will flower and produce seed in their first season, whereas smaller plants that stand less chance of successfully setting seed in their first season will delay reproduction until the following year. Thus, the biennial life form is maintained, despite the higher risk of mortality. Like many short-lived plants growing in arid environments, above-ground numbers of slickspot peppergrass individuals can fluctuate widely from year to year, depending on seasonal precipitation patterns (Mancuso and Moseley 1998, p. 1; Meyer et al. 2005, pp. 4, 12, 15; Palazzo et al. 2005, p. 9; Menke and Kaye 2006a, p. 8; Menke and Kaye 2006b, pp. 10, 11; Sullivan and Nations 2009, p. 44). Mancuso and Moseley (1998, p. 1) note that sites with thousands of above-ground plants one year may have none the next, and vice versa. Above ground plants represent only a portion of the population; the seed bank (a reserve of dormant seeds generally found in the soil) contributes the other portion and in many years, constitutes the majority of the population (Mancuso and Moseley 1998, p. 1). Seed banks are adaptations for survival in a "risky environment" because they buffer a species from stochastic (random) impacts, such as lack of soil moisture (Baskin and Baskin 2001, p. 160). Seed Viability and Germination: The seeds of slickspot peppergrass are found primarily within the slickspot microsites where the plants are found (Meyer and Allen 2005, pp. 5–6). Slickspots, also known as mini-playas or natric (high sodium content) sites, are visually distinct openings in the sagebrush-steppe created by unusual soil conditions characterized by significantly greater sodium and clay content relative to the surrounding area (Moseley 1994, p. 7). The vast majority of slickspot peppergrass seeds in slickspots have been located near the soil surface, with lower numbers of seeds located in deeper soils (Meyer et al. 2005, p. 19; Palazzo et al. 2005, p. 3). Slickspot peppergrass seeds have been found in slickspots even if no above-ground plants are present (Meyer et al. 2005, p. 22; Palazzo et al. 2005, p. 10). When above-ground plants are present, flowering usually occurs in late April and May, fruit set occurs in June, and the seeds are released in late June or early July. Seeds produced in a given year are dormant for at least a year before any germination takes place. Following this year of dormancy, approximately 6 percent of the initially viable seeds produced in a given year germinate annually (Meyer et al. 2005, pp. 17–18). When combined with an average annual 3 percent loss of seed viability, approximately 9 percent of the original seed cohort per year is lost after the first year. Thus, after 12 years, all seeds in a given cohort will likely have either died or germinated, resulting in a maximum estimated longevity of 12 years for seeds in the seed bank (Meyer et al. 2005, p. 18). The primary seed dispersal mechanism for slickspot peppergrass is not known (Robertson and Ulappa 2004, p. 1708), although viable seeds have been found outside of slickspots, indicating that some seed dispersal is occurring beyond slickspot habitat (Palazzo et al. 2005, p. 10). Slickspot peppergrass seeds located near the soil surface show higher rates of germination and viability (Meyer and Allen 2005, pp. 6–8; Palazzo et al. 2005, p. 10) and the greatest seedling emergence success rate (Meyer and Allen 2005, pp. 6–8). Viable seeds were more abundant and had greater germination rates from the upper 2 in. of soil (Palazzo et al. 2005, pp. 8, 10), while Meyer and Allen (2005, pp. 6–8) observed the upper 0.08 in. as optimal for germination. Deep burial of slickspot peppergrass seeds (average depths greater than 5.5 in.) can entomb viable seeds and may preserve them beyond the 12-year period previously assumed as the maximum period of viability for slickspot peppergrass seeds (Meyer and Allen 2005, pp. 6, 9). However, seeds buried at such depth, even if they remain viable, are unlikely to regain the surface for successful germination. The effects of environmental factors, such as wildfire, on slickspot peppergrass seed dormancy and viability are unknown although slickspot peppergrass abundance is reduced in burned areas. Pollination: Slickspot peppergrass is primarily an outcrossing species requiring pollen from separate plants for more successful fruit production and has a low seed set in the absence of insect pollinators (Robertson 2003, p. 5; Robertson and Klemash 2003, p. 339; Robertson and Ulappa 2004, p. 1707; Billinge and Robertson 2008, pp. 1005–1006). Slickspot peppergrass is able to self-pollinate, with a selfing rate (rate of self-pollination) of 12 to 18 percent (Billinge 2006, p. 40; Robertson et al. 2006a, p. 40). In pollination experiments where researchers moved pollen from one plant to another, fruit production was higher when pollen from distant sources was used (4 to 12.4 miles (mi)) between patches of plants) than when pollen from plants within the same patch was used (246 to 330 feet (ft)) between plants within the same patch) (Robertson and Ulappa 2004, p. 1705; Robertson et al. 2006a, p. 3). Fruits produced from fertilized flowers reach full size approximately two weeks after pollination (Robertson and Ulappa 2004, p. 1706). Each fruit typically bears two seeds that drop to the ground when the fruit dehisces (splits open) in midsummer (Billinge and Robertson 2008, p. 1003). Known slickspot peppergrass insect pollinators include several families of bees (Hymenoptera), including Apidae, Halictidae, Sphecidae, and Vespidae; beetles (Coleoptera), including Dermestidae, Meloidae, and Melyridae; flies (Diptera), including Bombyliidae, Syrphidae, and Tachinidae; and others (Robertson and Klemash 2003, p. 336; Robertson et al. 2006b, p. 6). In slickspot peppergrass insect pollinator studies conducted at three study sites, seed set was not limited by the number of pollinators at any study site (Robertson et al. 2004, p. 14). Studies have shown a strong positive correlation between insect diversity and the number of slickspot peppergrass plants flowering at a site (Robertson and Hannon 2003, p. 8). Measuring fruit set per visit revealed considerable variability in the effectiveness of pollination by different types of insects, ranging from 0 percent in dermestid beetles to 85 percent in honeybees (Apis mellifera) (Robertson et al. 2006b, p. 15).

**Habitat Type**

Adult: Volcanic plains

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2016)

**Habitat Narrative**

Adult: The range of slickspot peppergrass is restricted to the volcanic plains of southwest Idaho, occurring primarily in the Snake River Plain and its adjacent northern foothills, with a single disjunct population on the Owyhee Plateau. The plant occurs at elevations ranging from approximately 2,200 to 5,400 ft in Ada, Canyon, Gem, Elmore, Payette, and Owyhee Counties (Moseley 1994, pp. 3–9). Based on differences in topography, soil, and relative abundance, we have divided the extant slickspot peppergrass populations into three physiographic regions: the Boise Foothills, the Snake River Plain, and the Owyhee Plateau. The nature and severity of factors affecting the species also vary between the three physiographic regions for the purposes of analysis. For example, urban and rural development, agriculture, and infrastructure development has been substantial in the sagebrush-steppe habitat of the Boise Foothills and the Snake River Plain regions, while very little of these types of development have occurred within the Owyhee Plateau region. The biological soil crust, also known as a microbiotic crust or cryptogamic crust, is one component of quality habitat for slickspot peppergrass. Such crusts are commonly found in semiarid and arid ecosystems and are formed by living organisms, primarily bryophytes, lichens, algae, and cyanobacteria, that bind together surface soil particles (Moseley 1994, p. 9; Johnston 1997, p. 4). Microbiotic crusts play an important role in stabilizing the soil and preventing erosion, increasing the availability of nitrogen and other nutrients in the soil and regulating water infiltration and preventing the establishment of invasive plants (Brooks and Pyke 2001, p. 4 and references therein; Serpe et al. 2006, pp. 174, 176). These crusts are sensitive to disturbances that disrupt crust integrity, such as compression due to livestock trampling or off highway vehicle (OHV) use and are subject to damage by fire; recovery from disturbance is possible but occurs very slowly (Johnston 1997, pp. 10–11). Slickspot peppergrass occurs in slickspot habitat microsites scattered within the greater semiarid sagebrush-steppe ecosystem of southwestern Idaho. On a broad scale, the Snake River Plains and the Owyhee Plateau physiographic regions are volcanic in nature and underlain by Tertiary basalt or rhyolite; the adjacent Boise Foothill sites are underlain by Pliocene/Quaternary lacustrine deposits (Moseley 1994, p. 8). Slickspots are visually distinct openings characterized by natric soils and distinct clay layers; they tend to be highly reflective and relatively light in color, making them easy to detect on the landscape (Fisher et al. 1996, p. 3). Slickspots are distinguished from the surrounding sagebrush matrix as having the following characteristics: microsites where water pools when rain falls (Fisher et al. 1996, pp. 2, 4); sparse native vegetation, distinct soil layers with a columnar or prismatic structure, higher alkalinity and clay content, and natric properties (Fisher et al. 1996, pp. 15–16; Meyer and Allen 2005, pp. 3–5, 8; Palazzo et al. 2008, p. 378); and reduced levels of organic matter and nutrients due to lower biomass production (Meyer and Quinney 1993, pp. 3, 6; Fisher et al. 1996, p. 4). Fisher et al. (1996, p. 11) describe slickspots as having a “smooth, panlike surface” that is structureless and slowly permeable when wet, moderately hard and cracked when dry. Although the low permeability of slickspots appears to help hold moisture (Moseley 1994, p. 8), once the thin crust dries out, slickspot peppergrass seedling survival depends on its ability to extend its taproot into the argillic horizon (soil layer with high clay content) to extract moisture from the deeper natric zone (Fisher et al. 1996, p. 13). How long slickspots take to form is unknown, but is hypothesized to take several thousands of years (Nettleton and Peterson 1983, p. 193; Seronko 2006, in litt. p. 2). Climate conditions that allowed slickspot formation in southwestern Idaho are thought to have occurred during a wetter Pleistocene period. Holocene additions of wind-carried salts (often loess deposits) produced the natric soils characteristic of slickspots (Nettleton and Peterson 1983, p. 191; Seronko 2006, in litt., p. 2). Several hundred years may be necessary to alter or lose slickspots through natural climate change or severe natural erosion (Seronko 2006, in litt. p. 2). However, some researchers hypothesize that new slickspots are no longer being created given current climatic conditions (Nettleton and Peterson 1983, pp. 166, 191, 206). As slickspots in southwest Idaho appear to have formed during the Pleistocene and current climate conditions may not allow for the formation of new slickspots, the loss of slickspot microsites appears to be permanent. Some slickspots subjected to past light disturbance may be capable of reforming (Seronko 2006, in litt. p.2). However, disturbances that alter the physical properties of the soil layers, such as deep disturbance and the addition of organic matter, may lead to the destruction and permanent loss of slickspots. For example, deep soil tilling and adding organic matter and gypsum have been recommended for eliminating slickspots from agricultural lands in Idaho (Peterson 1919, p. 11; Rasmussen et al. 1972, p. 142). Slickspot soils are especially susceptible to mechanical disturbances when wet (Rengasamy et al. 1984, p. 63; Seronko 2004, in litt. pp. 1–2). Such disturbances disrupt the soil layers important to slickspot peppergrass seed germination and seedling growth and alter hydrological function. Meyer and Allen (2005, p. 9) suggest that if sufficient time passes following the disturbance of slickspot soil layers, the slickspot soil layers may regain their pre-disturbance configuration yet not support the species. Thus, while the slickspot appears to have regained its former character, some essential component required to sustain the life history requirements of slickspot peppergrass has apparently been lost, or the active seed bank is no longer present. Most slickspots are between 10 and 20 square feet (ft2) in size although some are as large as 109 ft2 (Mancuso et al. 1998, p. 1). Slickspots cover a relatively small cumulative area within the larger sagebrush-steppe matrix, and only a small percentage of slickspots are known to be occupied by slickspot peppergrass. Slickspot peppergrass has infrequently been documented outside of slickspots on disturbed soils, such as along graded roadsides and badger mounds. These are rare observations and the vast majority of plants documented over the past 19 years of surveys and monitoring for the species were within slickspot microsite habitats (USFWS 2006b, p. 20). For example, in 2002, a complete census of an 11,070-ac area recorded approximately 56,500 slickspots (Air Force 2003 in litt., p. 15), of which approximately 2,450 (about 4.0 percent) were occupied by slickspot peppergrass plants (Bashore, pers. comm. 2003, p. 1). Of the approximately 11,300 slickspot peppergrass plants documented during the survey effort, only 11 plants (less than 1 percent) were documented outside of slickspots (Air Force 2002, summary attachment, entire). Not all potential slickspot peppergrass habitats in southwest Idaho have been surveyed, and additional slickspot peppergrass sites may be found outside of areas known to be occupied. Recent modeling was completed to develop a high-quality, predictive-distribution model of slickspot peppergrass to identify potential habitat (Colket 2008, p. 1). The Bureau defines potential habitat as areas within the known range of slickspot peppergrass that have certain general soil and elevation characteristics that indicate the potential for the area to support slickspot peppergrass although the presence of slickspots or the plant is unknown (USBLM 2009, p. B–2). Although surveys were conducted in 2008 in some areas identified as previously unsurveyed habitat with potential to contain the species, these surveys did not result in any new locations of the species (Colket 2008, pp. 4–6). Slickspot peppergrass has also been surveyed for in eastern Oregon, but the species has never been found there (Findley 2003 in litt., p. 1). We have no historical records indicating that slickspot peppergrass has ever been found anywhere outside of its present range in southwestern Idaho.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decline of 30 to 70 percent

**Species Trends:**

Declining

**Resiliency:**

The majority of slickspot peppergrass populations do not meet minimum viability criteria for population size (at least 1,000 plants) and minimum patch size (at least 500 acres) suggested in this SSA. However, some populations may be unique; and therefore, important for population representation and redundancy. For example, none of the populations in the Foothills geographic area met Service minimum population viability criteria due to their low acreages.

Due to the high levels of habitat fragmentation in the Foothills geographic area associated with wildfire, invasive nonnative plants, and development as well as the patchwork of land ownership, it likely would not be feasible to achieve the 500-acre patch size suggested for minimum viability criteria at slickspot peppergrass Foothills populations. As some Foothills populations represent the lower elevation extent of the species, their conservation would be important to preserve slickspot peppergrass genetic diversity and unique habitats despite smaller habitat patch sizes (and in some cases, lower plant numbers). A combination of habitat enhancement or threat reduction actions within populations considered to be unique, regardless of whether they meet suggested minimum population viability criteria, may be appropriate to maintain (and possibly increase) population representation and species redundancy over time. Although based on essentially the same type of baseline data and calculation as MVP, Population Viability Analysis (PVA) addresses the survival probability of specific populations. Viability of slickspot peppergrass populations is important as populations with higher viability also have higher resiliency, and have a higher likelihood of regaining plant numbers following random stochastic events such as drought or localized ground disturbance. PVA is not an absolute measure of whether a population is or is not viable, but rather is a tool used to assess how natural or man-caused changes in conditions may influence population viability. Using IDFG rangewide population assessments, we identified six groupings of good to fair viability populations in relatively close geographic proximity that are scattered across the species' range (Table 8, see also Figure 2). These groupings of higher viability populations are indicative of population strongholds, and may provide for genetic exchange among populations within the same grouping. EOs and subEOs identified as having higher population viability within these six groupings increase resiliency to stochastic events, and their distribution across the range of the species contributes to species representation and redundancy. With the exception of the two groupings within the Jarbidge geographic area, these groupings of higher viability populations are located too distant for insect pollinators to facilitate genetic exchange among the groupings. In addition, some lower viability EOs either within a grouping or in a more isolated location may also be important for population representation and redundancy due to their genetic uniqueness or other characteristics. (USFWS, 2020)

**Representation:**

While genetic studies suggest that representation of the disjunct Jarbidge geographic area populations is high, representation is more limited for smaller populations located in the Snake River Plain and Foothills geographic areas, where smaller populations separated by greater geographic distances have lower genetic diversity. Maintaining connectivity within and between populations to the extent possible would be important to continued genetic diversity of slickspot peppergrass populations (USFWS, 2020).

**Redundancy:**

Using these NatureServe protocols, IDFG assessment of individual EOs and subEOs resulted in EOs and subEOs ranked as having good viability (B-ranked) to poor viability (D-ranked) (Table 6). Overall, there appears to be a relatively high level of population redundancy, as good to fair viability populations (B-, BC-, and C-ranked EOs and subEOs) are well distributed across the range of the species (Table 6, see also Figure 2). The majority of the 115 extant populations (66 percent) ranked by IDFG fall within the good to fair population viability categories. When considering the combined acreage of populations rangewide, 83 percent (13,402 acres) of slickspot peppergrass EO and subEO acreage is ranked as having good viability (B-ranked) (Figure 13). No EOs or subEOs were ranked A (excellent viability) or AB (excellent to good viability)

(USFWS, 2020).

**Number of Populations:**
19 (USFWS, 2021)

**Population Size:**
45,569 (USFWS, 2016)

**Population Narrative:**
The number of above-ground plants fluctuates widely from year to year and is strongly correlated with spring precipitation (Menke and Kaye 2006). Seeds can remain viable in the seed bank for at least 12 years (USFWS 2007). The persistent seed bank appears essential for population persistence in this species (Meyer et al. 2006). Also, the species may rely on years with extremely favorable environmental conditions to restock this seed bank; if every year were average in its desert environment, the species might not persist (Meyer et al. 2006). In 2011, 2012, and 2013 the total number of Lepidium papilliferum plants counted was the lowest since 2005, when complete counts for this species were initiated (16,462 plants in 2011; 9,245 plants in 2012; and 6,351 in 2013) (Kinter 2012, in litt.; Kinter 2015, in litt.). In 2014, however, 45,569 total plants were counted, which represented the third highest number of plants observed over the 10 years of HIP monitoring (Kinter 2015, in litt.). Previously, the lowest total number of plants counted occurred in 2006, with 17,543 plants, and the highest count was in 2010, with 58,921 plants (Idaho Department of Fish and Game (IDFG) 2012, p. 5) (USFWS, 2016). Based on IDFG's 2016 assessment of slickspot peppergrass populations, 19 EOs and subEOs contained 1,000 or more slickspot peppergrass plants during IDFG assessment field reviews or during annual monitoring in at least one of the six years between 2010 and 2015. The Service considers these 19 EOs and subEOs (17 B-ranked and 2 BC-ranked) to have the highest viability of all slickspot peppergrass populations. Habitat patch sizes for these 19 slickspot peppergrass EOs and subEOs range from about 2 acres to 7,164 acres. Only 6 of these 19 populations are greater than 500 acres in area. The area of the remaining 13 EOs, documented to support 1,000+ plants, range from 2 to 91 acres. Relative to larger acreage populations, these smaller acreage populations are expected to be more vulnerable to stochastic or catastrophic events, such as ground disturbance or wildfire, respectively. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Increased Frequency and Intensity of Wildfire (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The altered wildfire regime is one of the two primary causes of reduced quality of habitat for slickspot peppergrass. Across the intermountain west, increased frequency, severity, intensity, and extent of wildfire has converted vast areas of former sagebrush steppe ecosystem to nonnative annual grasslands. Invasive nonnative annual grasses, such as cheatgrass and medusahead, have contributed to increases in the amount and continuity of fine fuels across the landscape. As a result, the wildfire frequency interval of sagebrush steppe habitat has been drastically shortened from a historical range of approximately 60 to over 300 years (depending on the species of sagebrush and other site specific characteristics) to less than 5 years in many areas of the sagebrush steppe ecosystem (Billings 1990, pp. 307–308; Whisenant 1990, p. 4;

USGS 1999, in litt., pp. 1–9; West and Young 2000, p. 262; Bukowski and Baker 2013, p. 557). Not only are wildfires burning far more frequently, but these wildfires tend to be larger and burn more uniformly than those that occurred historically, resulting in fewer patches of unburned vegetation, which affects the post-fire recovery of native sagebrush steppe vegetation (Whisenant 1990, p. 4). However, because estimates of increased fire frequency are critically dependent on the spatial area and period over which authors use for their computations, each estimate of fire frequency in sagebrush steppe provides a perspective on the role of fire in the sagebrush ecosystem that must be interpreted using the appropriate scale (Miller et al. 2011, p. 165). (USFWS, 2020)

**Stressor:** Introduction and Spread of Invasive Nonnative Plants (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive, nonnative annual grasses can alter various attributes of ecosystems including geomorphology, wildfire regime, hydrology, microclimate, nutrient cycle, and productivity (for a summary, see Dukes and Mooney 2003, entire). Additionally, invasive nonnative annual grasses can negatively affect native plants, including rare plants such as slickspot peppergrass, through competitive exclusion, niche displacement, hybridization, and competition for insect pollinators. Examples of these negative effects are widespread among different taxa, locations, and ecosystems (D'Antonio and Vitousek 1992, pp. 63–87; Olson 1999, p. 5; Mooney and Cleland 2001, p. 1). (USFWS, 2020)

**Stressor:** Highly Competitive Nonnative Seeded Species (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Highly competitive nonnative seeded species are considered separately from invasive nonnative unseeded species, which includes annual invasive nonnative grasses and perennial noxious weeds. Both native and nonnative deep-rooted perennial bunchgrasses can play key roles in the ecological resilience of habitat to disturbances (such as wildfire and improper livestock grazing) and of ecological resistance to invasive nonnative annual grass establishment. Established perennial plants with well-developed root systems (Figure 17) can effectively compete with invasive nonnative annual grasses for water and nutrients. Both established native and nonnative deep-rooted perennial grasses can limit the spread of invasive nonnative annual grasses such as cheatgrass (Davies and Johnson 2017, p. 748; Clements et al. 2017, pp. 179-180, Ott et al. In press, pp. 6, 10). Seeded deep-rooted nonnative perennial species, such as crested wheatgrass and forage kochia, have been extensively used for post-fire soil stabilization efforts in the Great Basin, including within the range of slickspot peppergrass, due to their ability to decrease soil erosion risk, exclude cheatgrass at a lower cost than native species, and their relative ease of establishment compared with native perennial bunchgrasses (Davies et al. 2013, p. 472). (USFWS, 2020)

**Stressor:** Development (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** In the Service's 2009 listing rule, residential, commercial, and agricultural development was identified as a secondary threat to slickspot peppergrass in the Foothills and Snake River Plain geographic areas (74 FR 52036-52037). More recently, residential and commercial development, inclusive of infrastructure, was identified as one of the most extreme and widespread disturbances documented to impact the species within the Foothills and Snake River Plain geographic areas (Miller and Kinter 2018, p. 38). Development can affect slickspot peppergrass through direct destruction of populations and loss of slick spot microsites. Development can also have indirect impacts by contributing to nonnative plant invasions, particularly along associated utility lines and roads, which act as corridors for nonnative plant invasions (Forman and Alexander 1998, p. 210; Gelbard and Belnap 2003, pp. 424-425, 430-431; Bradley and Mustard 2006, p. 1142); increased human-caused ignition of wildfires, presumably by increasing the area of the urban-wildland interface (e.g., Keeley et al. 1999, p. 1829; Romero-Calcerrada et al. 2008, pp. 341, 351; Syphard et al. 2008, pp. 610-611); increased off road vehicle use; and increased habitat fragmentation, which can pose problems for slickspot peppergrass by creating barriers in the landscape to pollinators that prevent effective genetic exchange within or among populations (Robertson et al. 2004, pp. 2-4). (USFWS, 2020)

**Stressor:** Owyhee harvester ants (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While effects of herbivory on slickspot peppergrass by mammals and most insects has not been identified as a significant stressor (IDFG in litt. 2018, p. 6), in recent years, concern has emerged over potential detrimental effects of seed predation by Owyhee harvester ants. Owyhee harvester ants are a native species that thrive in open grassy areas throughout southwest Idaho, including areas occupied by slickspot peppergrass where shrubs have been lost. These ants consume the seeds of small-seeded species (including slickspot peppergrass) preferentially over large-seeded species such as cheatgrass (Schmasow and Robertson 2016, p. 955). Studies have shown that Owyhee harvester ants can remove up to 90 percent of slickspot peppergrass fruits and seeds from individual plants, either directly from the plant or by scavenging seeds that drop to the ground (White and Robertson 2009b, p. 511; Robertson and Crossman 2012, pp. 14-15; Jeffries 2016, entire). The extent to which seed predation by harvester ants impacts slickspot peppergrass seed recruitment within slick spots and populations is currently under investigation. Slick spots with low numbers of flowering slickspot peppergrass plants are likely to suffer high levels of seed loss in a given year (based on the results of White and Robertson 2009b, Robertson and Crossman 2012, and Jeffries 2016), whereas slick spots with large numbers of plants may overwhelm the ants' capacity to consume seeds (Robertson 2018, personal communication). (USFWS, 2020)

**Stressor:** Improper Livestock Grazing (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Livestock use is widespread across the range of slickspot peppergrass. Livestock use in areas that contain slickspot peppergrass can result in both positive and negative effects on the species, depending on factors such as intensity, timing, and duration of use. Livestock grazing may be used as a tool to ameliorate the primary threats of wildfire and invasive annual grasses on slickspot peppergrass. Domestic cattle are not known to feed on slickspot peppergrass, and

domestic sheep have been observed uprooting but not consuming plants (D. Quinney and J. Weaver pers. comm. 1998). Although direct herbivory of slickspot peppergrass by livestock has not been documented to occur, livestock grazing can impact slickspot peppergrass through trampling and interactions with the nonnative invasive plant cycle. (USFWS, 2020)

**Stressor:** Climate Change (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Warmer temperature regimes and changes in precipitation associated with global climate change represent another risk factor for slickspot peppergrass. Consequences of climate change, if current projections occur, are likely to exacerbate existing primary threats (modified wildfire regime and invasive nonnative plants, particularly cheatgrass) to slickspot peppergrass conservation. Researchers confirmed “experimentally that, in an intact ecosystem, elevated carbon dioxide may enhance the invasive success of Bromus spp. in arid ecosystems,’’ and suggest that this enhanced success will then expose these arid areas to accelerated wildfire cycles (Smith et al. 2000, p. 81). Chambers and Pellant (2008, p. 32) also suggest that higher carbon dioxide levels are likely increasing cheatgrass fuel loads due to increased productivity, with a resulting increase in wildfire frequency and extent. Furthermore, current climate change models predict future climatic conditions within the range of slickspot peppergrass will favor further invasion by cheatgrass (Smith et al. 1987, pp. 142-143; Smith et al. 2000, p. 81; Brown et al. 2004, p. 384; Neilson et al. 2005, pp. 150, 156; Chambers and Pellant 2008, pp. 31-32). These and other models (Littell et al. 2009, p. 1019; Abatzoglou and Kolden 2013, p. K; Westerling et al. 2014, p. 91; McKenzie and Littell 2017, p. 29) also project that wildfire frequency will continue to increase, and the extent and severity of wildfires may increase as well. Thus, the projected consequences of climate change are acting to exacerbate the primary threats of frequent wildfire and invasive nonnative plant species on slickspot peppergrass throughout its range. (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 11C

**Delisting Criteria:**
Not available; a Recovery Plan has not been issued.

**Recovery Actions:**
- Not available; a Recovery Plan has not been issued.

***Conservation Measures and Best Management Practices:***
- Currently, there are six formalized plans that incorporate specific conservation measures for slickspot peppergrass: • The Candidate Conservation Agreement for Slickspot Peppergrass between the State of Idaho, BLM, Idaho Army National Guard and nongovernmental cooperators (private landowners who also hold livestock grazing permits on BLM lands) (State of Idaho et al. 2003, as updated in 2006); • The BLM and U.S. Fish and Wildlife Service Conservation Agreement for existing BLM land use plans (USBLM and USFWS 2006, as updated in 2009, 2013, and 2014). Once conservation measures of identical or greater conservation value are incorporated into all applicable

BLM land management plans, the term of this Conservation Agreement will be concluded. One applicable BLM land management plan where conservation measures have yet to be incorporated (the Four Rivers Resource Management Plan) remains. Conservation measures with identical or greater conservation value than this Conservation Agreement have been incorporated into two recent BLM land use plans: o The 2008 Morley Nelson Snake River Birds of Prey National Conservation Area Resource Management Plan (as contained within Appendix 8 of the 2008 Record of Decision), and o The 2015 Jarbidge Approved Resource Management Plan. • The Idaho Army National Guard's Integrated Natural Resource Management Plan for the Orchard Combat Training Center (National Guard 1991, as updated in 1997, 2004, 2008, and 2013); and • The Mountain Home Air Force Base's Integrated Natural Resource Management Plan, which includes the Juniper Butte Range (Air Force 2004, as updated in 2012 and 2018). (USFWS, 2020)

- The BLM's Jarbidge and the Paradigm fuel break projects have the potential to reduce the risk of wildfires within portions of the range of slickspot peppergrass. However, these fuel break projects do not address the co-occurring effects of existing invasive nonnative annual grasses, one of two primary threats identified for the species, or the conservation need for sagebrush steppe habitat restoration. Considering all of these factors, it is unlikely that these large fuel break projects on their own will adequately address threats such that future population viability is maintained or improved in this portion of the species range. Although fire suppression, including Rangeland Fire Protection Associations, and fuels management efforts currently in place are a positive conservation step for slickspot peppergrass and its habitat, they are not sufficient at this time to offset effects of current and future extent of invasive nonnative plants or other threats across the range of the species. Effective control of the most significant threats to slickspot peppergrass (wildfire and invasive nonnative plant species, especially invasive nonnative annual grasses) may require efforts that extend beyond the boundaries of slickspot peppergrass populations since these threats are naturally expansive and occur throughout the Great Basin at landscape levels. (USFWS, 2020)
- Approximately 45 percent of slickspot peppergrass habitat is currently located within RFPA or Mutual Aid boundaries, and 70 percent of EO acres located on State Endowment Trust Lands are within fire protection boundaries (1.015 of 1,454 acres) (IDL in litt. 2018, p. 1). However, these areas continue to be at a high risk of large catastrophic wildfires based on conditions associated with low ecological resistance and resilience areas (Chambers et al. 2014a, entire). In addition, while RFPAs have the potential to influence the overall effect of wildfires, they do not address the threat from existing invasive nonnative plant species, the second of two primary threats identified for the species, or the conservation need for sagebrush steppe habitat restoration. Therefore, while the formation of RFPAs are a positive conservation step for sagebrush steppe habitat, RFPAs have not yet shown to be sufficiently effective to offset the primary threat of wildfire to the species. (USFWS, 2020)
- While the Jarbidge and the Paradigm fuel breaks projects have the potential to reduce the risk of wildfires within portions of the range of slickspot peppergrass, these fuel break projects do not address the co-occurring effects of existing invasive nonnative plant species, one of two primary threats identified for the species, or the conservation need for sagebrush steppe habitat restoration. Addressing existing invasive nonnative plants and the restoration of sagebrush steppe habitat are not within the scope of these fuel breaks projects. Considering all of these factors, it is unlikely that these large fuel break projects on their own will adequately address threats such that rangewide future species viability is maintained or improved. Although wildfire suppression, including RFPAs, and fuels management efforts currently in place are a positive conservation step for slickspot peppergrass and its habitat, they are not sufficient at this time to offset effects of current and future extent of invasive nonnative plants or other threats across the range of the species. (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS Proceed with the development of a Recovery Plan and an associated Recovery Implementation Strategy for the slickspot peppergrass that includes specific, objective, and quantifiable recovery criteria and actions. • Collaborate with the Slickspot Peppergrass Technical Team and other experts to determine recovery requirements for the species. • Develop a strategy for maintaining or restoring Wyoming big sagebrush habitat within and adjacent to slickspot peppergrass element occurrences, which emphasizes the use of native shrubs, grasses, and forbs to benefit slickspot peppergrass and its insect pollinators. • Investigate rangewide population genetics using recent technologies to identify and prioritize conservation of slickspot peppergrass element occurrences essential for maintaining genetic diversity of the species into the future. (USFWs, 2021)

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# SPECIES ACCOUNT: *Lespedeza leptostachya* (Prairie bush-clover)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 01/09/1987; Great Lakes - Big Rivers Region (R3) (USFWS, 2016). Recommended for delisting (2021a)

**Physical Description**

Herbaceous perennial; sericeous stems of mature plants are erect, up to a meter tall, and may be either simple or branched. The linea ror narrowly oblong leaflets of the trifoliate leaves are 2-4 cm long and 2-8 mm wide with appressed pubescence above and silky hairs below. The longer terminal leaflets are lss than half as wide as long, with petioles 2-10mm long. Petals of the chasmogamous (open, potentially outcrossing) flowers are white, or yellowish-white to light pink with a magenta mark in the center of the keel and are between 4 and 6 mm in length. The cream-colored petals of closed, obligately self-pollinating cleistogamous flowers develop within and are usually surrounded by the calyx, which reaches a length of 4.5 to 5 mm when fully developed. Both types of flowers may occur on a single plant or an individual plant may exhibit cleistogamous flowers only (USFWS, 1988).

**Taxonomy**

In the pea family (Fabaceae). There are 40 members o fthis genus, of which 12 are native to North America. Also known as slender-leaved bush clover (USFWS, 1988)

**Historical Range**

Former range included 27 counties in Minnesota, Wisconsin, Iowa, and Illinois (USFWS, 1988).

**Current Range**

Prairie bush-clover has been found across four states: Illinois, Iowa, Minnesota, and Wisconsin (Figure 1.2). Populations considered historical around the time of listing (1988) were documented in 28 counties across all four states (USFWS 1988, p. 4). The number of known extant populations has increased in Iowa, Minnesota, and Wisconsin. Additional populations were found in Minnesota as a result of increased survey effort post-listing. For example, seven new prairie bush-clover populations were discovered in 1990 (Sather 1991, p. 1). (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (NatureServe, 2015)

**Lifespan**

Adult: 30 years (USFWS, 2021)

**Breeding Season**

Adult: July - September (NatureServe, 2015; USFWS, 1988), Seed germination begins in May and continues through July (USFWS 1988, p. 12; Figure 1.5), the production of chasmogamous flowers lasts until mid-August and the production of cleistogamous flowers occurs into September

**Key Resources Needed for Breeding**

Adult: Insect pollinators, possibly scarification/fire (NatureServe, 2015)

**Other Reproductive Information**

Adult: The longevity of prairie bush-clover seeds in the soil is relatively unknown; however, a study examining seed germination and the seed bank of prairie bush-clover found that the large majority (about 95%) of seeds germinated during the second year. Individual prairie bush-clover plants have been documented entering a period of dormancy that may last 1-2 years. Individual plants may enter dormancy in response to increased competition and/or lack of disturbance (grazing) (Bockenstedt 2002, p. 45). (USFWS, 2021)

**Reproduction Narrative**

Adult: Blooms mainly in mid-July. Lespedeza species produce both larger, showy chasmogamous flowers and greatly reduced cleistogamous flowers. The cleistogamous flowers are obligately self-pollinated. Clewell (1966a) demonstrated that the chasmogamous flowers of other members of the genus are more often self- pollinated than cross-pollinated, thus Lespedeza has a strong tendency towards autogamy. In one study, only 20% of pods contained seeds (Baskin pers. comm.). Pollinators for some other Lespedeza species are known: Bombus fraternus (L. capitata and L. virginica), Xylocopa micans (L. steuvei, L. angustifolia), Campsomeris plumipes (same species), and Epargyreus clarus (same species). Haugen and Fitch (1955) have suggested that surface fire might cause scarification in Lespedeza bicolor. Clewell (1966a) found that germination success of L. cuneata increased following heating in an oven 90C for 30 minutes. On the other hand, L. leptostachya has been germinated in both Illinois and Kentucky without scarification (Kurz and Bowles 1981, Baskin pers. comm.). Smith (pers. comm.) has observed germination in the absence of fire every year for four years at one site in Minnesota (NatureServe, 2015). Plants under cultivation have been observed to flower the same year they germinated, whereas wild plants may require 5 or more years to reach maturity. Mature plants have been observed to flower repeatedly over four sequential sampling seasons. It is estimated that individual plants frequently live ten years or more. Growth and development of terminal inflorescences continues into early September (USFWS, 1988).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Dry to mesic gravel and sandy prairie (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Possibly a disturbance regime (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: 0.3 - 1.9 per sq. m (USFWS, 1988)

**Tolerance Ranges/Thresholds**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits dry gravel prairies and dry-mesic prairies in Illinois (Steyermark and Swink 1955, Kurz and Bowles 1981), dry-mesic prairies in Minnesota (Smith 1981) and Iowa (Huston 1981), dry prairie and sandy prairie in Wisconsin (Tans and Read 1975). Characteristics of dry gravel and dry-mesic prairies in Illinois include steep, well-drained, usually calcareous soil sites (White and Madany 1978). Smith (1981) noted that five of six Minnesota sites are north or northwest-facing slopes of 10 to 15 degrees, all well drained (the sixth site was on level ground). Apparently withstands moderate grazing. May require disturbance for reproduction and to reduce competition (NatureServe, 2015). Estimates of density in 1986 range from 0.3 to 1.9 plants per square meter (USFWS, 1988). Prairie bush-clover is endemic to Midwestern prairies in Illinois, Iowa, Minnesota, and Wisconsin. The majority of populations at the time of listing were found on gentle, north-facing slopes of 10-15 degrees. Surveys conducted over the last thirty years have found that the species can occur on north, west, and east-facing slopes. Plants are usually found around the edges of slopes or within barely concave areas that are not subject to nutrient or herbicide input from drain-tile discharge (Nancy Sather, Minnesota Department of Natural Resources (MNDNR), retired, pers. comm, June 30, 2021). Soil types include, but are not limited to fine silty loam, sand, fine sandy loam, or clay loam (USFWS 1988, p. 2; Cole and Biesboer 1992, p. 567). Prairie bush-clover also occurs at bedrock outcrop sites interspersed with upland prairie (USFWS 1988, p. 8). The species occurs on disturbed sites or prairie habitats that have been previously mowed, burned, cultivated, or grazed, in addition to undisturbed remnant prairie sites (USFWS 1988, p. 7, Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Prairie bush-clover can thrive in great numbers on actively grazed sites (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). The known range of prairie bush-clover overlapped with the bison (Bison bison) range and, as a result, the species co-evolved with grazing (Todd Bittner, Cornell Botanical Garden, pers. comm., June 22, 2021). Many sites that are currently protected in Minnesota are former pastures where the species was discovered only when systematic grassland surveys targeted them as potential habitat. At one heavily grazed pasture site in Minnesota, 1,117 prairie bush-clover plants shorter than 10 cm (3.9 inches) were discovered. The population was similar to other formerly grazed sites where flowering prairie bush-clover plants are visible approximately three years after the cessation of grazing (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). At formerly cultivated sites, the species was visible and widely dispersed across the site, rather than the patchy distribution common at southwestern Minnesota sites, a few years after cultivation ended. It is likely that prairie bush-clover seeds in the seed bank were spread across the site due to cultivation practices (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021) (USFWS, 2021).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Within the genus there are no special structures to aid in seed dispersal, and seed dispersal is probably via animals consuming the fruits and passing the seeds. Clewell (1966a) tested 108 seeds of other members of the genus that were consumed by bobwhite quail (Colinus virginianus) and obtained 100% germination success. He also tested 16 seeds that were consumed by small mammals, and obtained 89% germination success (NatureServe, 2015). Seed dispersal mechanisms for prairie bush-clover are largely unknown; however, seeds are thought to be dispersed by either gravity or animal activity (for example, voles, small rodents) (Bockenstedt 2002, p. 4). (USFWS, 2021)

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2021a)

**Resiliency:**

Thirty-seven prairie bush-clover populations or 33% currently exhibit excellent or good resiliency across all four states in the geographic range. The 12 populations that are in excellent condition all have over 1000 individual prairie bush-clover plants and no evidence of significant and recent (defined as occurring over the last 20 years) decline. The majority (8 or 67%) of the populations ranked as excellent are composed of high-quality prairie with minimal threats due to persistent management and 10 or more acres of contiguous suitable habitat. Ten populations with excellent resiliency are owned by a conservation organization or are permanently protected for purposes of conservation. One population is owned privately or by an organization that is currently interested in conservation and one population is currently not protected. The 25 prairie bush-clover populations currently ranked as having good resiliency all have at least 10 individual plants, with the majority of those populations having 100 or more. All but two of these populations occur in areas with high or fair quality prairie habitat with minimal threats and/or persistent management. Two populations occur at sites with degraded prairie habitat and inconsistent management. The amount of suitable contiguous habitat at populations with good resiliency varies from less than 1 acre to 10 or more acres. The majority (18 or 72%) of prairie bush-clover populations exhibiting good resiliency are owned by a conservation organization and are permanently protected for purposes of conservation. Five populations are currently unprotected with no informal agreement in place. One population is owned privately or by an organization that is currently interested in conservation and one population has an informal agreement in place. The majority, 76 populations or 67%, of prairie bush-clover populations rangewide currently exhibit fair or poor resiliency. Populations with fair resiliency have 99 or fewer plants or have shown significant recent decline (as determined by state biologists and species experts), degraded habitat due to high impact grazing, brush encroachment and/or non-native, invasive species, with inconsistent management. These populations are generally characterized as having one to four acres of contiguous suitable habitat and the landowner has an informal conservation agreement in place. Thirty-five populations currently have poor resiliency. Populations exhibiting poor resiliency generally have fewer than 10 plants or have shown significant recent decline and are present in low quality habitat with no management. Non-native, invasive species are the dominant vegetation at these sites and suitable contiguous habitat is less than one acre. The sites are not protected from future land conversion. In addition, 12 populations are currently considered extirpated. (USFWS, 2021).

**Representation:**

The distribution of extant prairie bush-clover (Lespedeza leptostachya) by representative category. Representative Category. Dry Prairie. Number of Extant Populations: 52. Percent of Populations 46%. Representative Category. Dry-Mesic Prairie. Number of Extant Populations: 41. Percent of Populations 36%. Representative Category. Mesic Prairie. Number of Extant

Populations: 14. Percent of Populations 12%. Representative Category. Bedrock Prairie. Number of Extant Populations: 6. Percent of Populations 5%. (USFWS, 2021).

**Redundancy:**

Redundancy describes the ability of a species to withstand catastrophic events by maintaining multiple, resilient populations across the species' geographic range. The redundancy of prairie bush-clover is based on its 113 extant populations distributed across Illinois, Iowa, Minnesota, and Wisconsin and the four prairie habitat types that we define as representative categories. Individual populations in each of the four prairie habitat types (representative categories) are dispersed throughout the species' overall range, and, therefore, are distributed geographically. Thus, the number and resiliency of populations in each representative category also characterizes current distribution (redundancy) in terms of the spatial impact of a catastrophic event. (USFWS, 2021).

**Number of Populations:**

113 (USFWS, 2021)

**Population Size:**

24,530 (USFWS, 1998)

**Population Narrative:**

There are about 32 extant populations, and many of these are small (<150 stems) (NatureServe, 2015). Total population size in peripheral populations is 1,923 and 22,607 in core populations (USFWS, 1988). As of 2020 (over 30 years later), there are 113 known extant populations across the four states (USFWS, 2021). The number of known populations of prairie bush-clover has increased from 36 populations at the time of listing in 1987 (52 FR 783) to 113 populations today. The number of known extant populations has increased in Iowa, Minnesota, and Wisconsin. Additional populations were found in all four states as a result of increased survey effort post-listing. For instance, seven new prairie bush-clover populations were discovered in Minnesota in 1990 (Sather 1991, p. 1) (USFWS, 2021a).

***Threats and Stressors***

**Stressor:** Habitat loss and degradation (USFWS, 1988)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threatened by loss of habitat due to agriculture and urbanization, may be threatened by plant succession, lack of natural disturbance (which prevents shrub invasion) at individual sites, and slow germination and seedling establishment rates. Specific threats to occurrences include use of herbicides or run-off containing herbicides at Cihak Prairie (Jackson Co., Minnesota; Smith 1981). Quarry operations threaten the Morton Outcrop (Renville Co., Minnesota; Smith 1981) site and the Winnebago Co. (IL) site (Kurz and Bowles 1981). At least four sites are presently being grazed (USFWS 1987). Woody species invasion threatens two sites in Wisconsin and two in Minnesota (USFWS 1987). Roadside mowing and weedy vegetation is threatening a site near a housing development in Wisconsin (Richardson pers. comm.) (USFWS, 1988).

**Stressor:** Herbivory (USFWS, 1988)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory by both insects and mammals may contribute to mortality. Insect herbivory has been reported for Illinois, Minnesota and Iowa populations. Young leaves and growing tips of young plants are damaged by insects throughout the summer. There is evidence of infestation by Cuculionid or Brucid beetles in Minnesota populations. At time, damage by mammals may reach significant proportions in localized areas (USFWS, 1988).

**Stressor:** Succession (USFWS, 1988)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Tentative evidence suggest that L. leptostachya is detrimentally affected by woody invasion but no data are available adequately to evaluate the threats (USFWS, 1988).

**Stressor:** Hybridization (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hybridization with L. capitata is known to have occurred at two sites in Minnesota, one in Iowa, and one in Illinois (USFWS 1988).

**Stressor:** Herbicide Use
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Incompatible use of herbicides at known population sites would directly impact an individual plant’s ability to produce seeds and may disrupt connectivity across microhabitats. Seed dispersal may also be impacted due to a decline in pollinators, which are largely unknown for prairie bush-clover. Prairie bush-clover populations located near agricultural fields or adjacent to existing roadways may be at increased risk of exposure to herbicide use (USFWS 1988, p. 15). (USFWS, 2021).

**Stressor:** Habitat Conservation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Conversion of documented prairie bush-clover sites to row crops and gravel quarries has destroyed at least two sites in Wisconsin and Illinois (USFWS 1988, p. 14). Agricultural activity resulting in a direct conversion to row-crops destroyed at least one known prairie bush-clover site in Wisconsin (USFWS 1988, p. 14). Conversion of documented populations to rock or gravel quarries has occurred at least once in Illinois (USFWS 1988, p. 15). One unprotected Illinois population was lost due to commercial development (Todd Bittner, Cornell Botanic Garden, pers. comm., June 22, 2021). Extant prairie bush-clover populations located on private land are at risk of conversion to row crop or rural residential development (USFWS 1988, p. 14), and populations located adjacent to existing rights of way are at risk due to potential roadway expansion in the

future (USFWS 1988, p. 15). (USFWS, 2021).

**Stressor:** Climate Change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change may act as a stressor on the species by promoting non-native vegetation growth and exacerbating drought conditions. Changes in precipitation regimes are anticipated with fewer, but larger events followed by prolonged dry periods and drought stress (Knapp et al. 2008, p. 816). These alterations may create novel ecosystems that suppress native plant species and promote expansion of invasive, non-native species into prairie bush-clover habitat (Knapp et al. 2008, p. 817). Climate change may also promote dominant, non-native vegetation growth and encroachment with the increase in $CO_2$ and subsequent increase in plant biomass (Blumenthal et al. 2013, p. 1161). Increased biomass at sites with prairie bush-clover populations may lead to increases in thatch, or layer of organic plant matter, which makes seed germination increasingly difficult. Altered precipitation and temperature regimes may influence when management activities in prairie habitat can occur by increasing or reducing opportunities for the use of prescribed fire. Prolonged periods of warmer temperatures may allow for more opportunities for prescribed burning, while increased precipitation in the spring or early summer may constrain when prescribed burns may occur. Ultimately, the timing of prescribed burns may become increasingly unpredictable due to variable temperatures and changes in precipitation regimes (Wisconsin Initiative on Climate Change Impacts 2017). (USFWS, 2021).

**Stressor:** Dominant Vegetation Encroachment
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Prairie systems are reliant on natural disturbance regimes to maintain the structure of the prairie. Without fire, grazing, or other natural disturbances, prairie communities may transition to scrubshrub or early successional habitat types. Mature prairie bush-clover plants can succumb to prolonged competition with woody vegetation encroachment. This has been documented at populations in Wisconsin and Minnesota (Nancy Sather, MN DNR retired, pers. comm., June 30, 2021). There are a number of invasive, non-native plant species, including buckthorn, that currently pose a threat to prairie bush-clover populations with no active management or management plans in place. Native dominant woody plant species documented at sites include: Buckthorn species (Ceanothus species), Hawthorn species (Crataegus species), eastern red cedar (Juniperus virginiana), quaking aspen (Populus tremuloides), cherry species (Prunus species), burr oak (Quercus macrocarpa), black oak (Quercus velutina), smooth sumac (Rhus glabra), staghorn sumac (Rhus typhina), western snowberry (Symphoricarpos occidentalis), and riverbank grape (Vitis riparia) (USFWS 1988, p. 10). (USFWS, 2021).

**Stressor:** Drought
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Prairie bush-clover predominantly occurs in habitats with dry soil types (dry prairie, bedrock prairie) or characteristics (dry-mesic prairie), which makes the species relatively droughttolerant; however, populations at sites with mesic soil types (mesic prairie) may be

subjected to additional stress from prolonged drought periods (Knapp et al. 2008, p. 816). Prolonged drought events lasting multiple consecutive growing seasons may have long lasting impacts on populations. If conditions are not favorable, the prairie bush-clover may enter a state of dormancy for a year; however, if unfavorable conditions persist for two or more years, dormant plants may not survive. Non-dormant plants may produce fewer chasmogamous flowers which may further impact the genetic diversity of a population. A prolonged drought may also have a significant impact on seedling survival (Kevin Doyle, Wisconsin Department of Natural Resources, pers. comm., June 22, 2021). (USFWS, 2021).

**Stressor:** Hybridization
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There have been numerous documented reports of hybridization between prairie bush-clover and round-headed bush clover (Lespedeza capitata) in all four states (Fant et al. 2010, p. 2197). Both species are found in remnant prairie habitats and have overlapping flowering periods (USFWS 1988, p. 16). Hybrids have been documented at Minnesota sites since the early 1980s (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Numerous hybrid plants were observed at Jeffers Petroglyphs National Monument in 1995 (MN Natural Heritage Program 1995, p. 4). The number of prairie bush-clover populations with hybrids and the number of hybrid plants within populations has steadily increased since 1987, when only two Minnesota populations had documented hybrids (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Now hybrids are present in all four states in the prairie bush-clover range (Fant et al. 2010, p. 2197). No systematic documentation of hybrids has been conducted in Minnesota; however, biologists recently discovered that one of the first populations to support hybrids had been completely swamped by morphological hybrids (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Hybrid plants have vegetative traits (stem circumference, leaf width, and petiole length) that often are intermediate between the round-headed bush clover and the prairie bush-clover. Genetic testing indicated that prairie bush-clover acts as the seed-bearing parent (Fant et al. 2010, p. 2202). The hybrid plants may also be capable of self-fertilization, as both parent species produce cleistogamous flowers. At least one instance of back-crossing has been observed at a site in Minnesota. This occurs when a hybrid individual crosses with one of the hybridizing species (round-headed bush clover or prairie bush-clover) and produces an offspring that is morphologically and genetically similar to the parent, in this case, prairie bush-clover (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Prairie bush-clover is not a genetically diverse species, so genetic assimilation to round-headed bush clover may serve as a threat to the genetic diversity of prairie bush-clover (Fant et al. 2010, pp. 2203). For this report, we considered the potential impacts of hybridization qualitatively, rather than quantitatively as it's unclear how many populations have documented hybrid plants. (USFWS, 2021).

***Recovery***

**Reclassification Criteria:**
Not available

**Delisting Criteria:**
1. Protect and bring under appropriate management a minimum of twenty viable naturally-occurring populations of prairie bush-clover within the core habitat area (USFWS, 1988).

2. Protect and manage a minimum of fifteen viable naturally-occurring populations (representing the full range of habitat types) outside the core habitat area (USFWS, 1988).

**Recovery Actions:**

- Protect selected viable populations and their habitat. Initiate landowner awareness and permanent portection activities. Stabilize protection with long-term management plans and agreements (USFWS, 1988).
- Provide appropriate management at each protected site (USFWS, 1988).
- Inventory to locate additional populations. Search historical sites where prairie bush clover has been found and habitat is still present. Identify and search potential new sites (USFWS, 1988).
- Monitor population trends at known sites (USFWS, 1988).
- Establish artificial seed banks for selected populations (USFWS, 1988).
- Provide appropriate public information (USFWS, 1988).
- Conduct appropriate research. Determine important habitat parameters, including characterization of soils. Increase knowledge of species and population biology (life history, population structure and dynamics, competition, predation). Determine natural seed bank (USFWS, 1988).
- Study the response of populations to a variety of potential management techniques (fire, grazing, mowing, pesticides, shrub and tree removal) (USFWS, 1988).
- Determine genetic diversity within and between populations (USFWS, 1988).
- Management objectives should include maintaining population size in good condition occurrences and increasing population size in degraded occurrences. Monitoring should be used to track the accomplishment of these objectives. Monitoring will be critical at Anderson Prairie, Iowa, where the herbicides Banvel and 2,4,D were applied to an area with two stands of L. leptostachya in June 1985 (Roosa pers. comm.) (NatureServe, 2015).
- In Minnesota, Smith (pers. comm.) has been monitoring one population using a bi-coordinate system that enables workers to map and relocate individual plants and to record demographic data each year. Smith's method has also been adapted for use at another site in Minnesota (Sather 1987) and one in Iowa (Nekola 1985) (NatureServe, 2015).
- In Illinois, yearly stem counts are taken at sites being monitored for management response (Schwegman pers. comm., Packard pers. comm.) (NatureServe, 2015).
- In Wisconsin, stem counts are made each year (Martin, Richardson, pers. comm.) (NatureServe, 2015).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Over the next five-years, the following conservation actions are recommended to directly benefit and assist in the continued recovery of prairie bush-clover. • Coordinate survey efforts across the geographic range of the species and assess the status of populations that have not been monitored for over 10 years (2011 or earlier) with an emphasis on populations characterized as having excellent or good resiliency. • Increase the number of protected populations across representative categories. This may include implementing and/or increasing outreach efforts with private landowners. • Manage habitat to support prairie bush-clover populations through practices that duplicate the natural processes of the prairie ecosystem (prescribed burns, grazing, or other methods to manage non-native, invasive species and/or encroaching woody vegetation). • Encourage and support research focused on identifying and documenting prairie bushclover pollinators, their abundance, and life histories. (USFWS, 2021a).

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# SPECIES ACCOUNT: *Lesquerella lyrata* (Lyrate bladderpod)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 9/29/1990; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

An annual made up of one to several, usually simple and erect stems of 1 to 3 decimeters (din) (4 to 12 inches) (in.) in length. Leaves and stems are shortly pubescent. The outer stems are usually decumbent at the base. Basal leaves are stalked and lyrate-shaped, 2 to 7 centimeters (cm). (0.8 to 2.8 in.) long and 6 to 15 millimeters (mm) (0.2 to 0.6 in.) wide. The terminal lobes are large and orbicular to elliptic in shape. The stem leaves are ovate to broadly oblong and obtuse, 5 to 20 mm (0.2 to 0.8 in.) long and 4 to 10 mm (0.2 to 0.4 in.) wide, and sessile with prominent ear-like projections (auricles) at the bases. The margins of the stems are nearly smooth to coarsely toothed. Inflorescences are dense. The flowers are ascending on densely pubescent stalks 1 to 1.5 cm (0.4 to 0.6 in.) long. Sepals are pubescent, yellowish, oblong, 3 to 4 mm (0.1 to 0.2 in.) long and 1.2 to 1.5 mm (0.1 in.) wide. Petals are yellow, broadly ovate, 5 to 7 mm (0.2 to 0.3 in.) long and 3.5 to 4 mm (0.1 to 0.2 in.) wide, and slightly rounded. The fruits are siliques, which are glabrous, globose in shape, 2.5 to 3.5 mm (0.1 in.) high and 3 to 4 mm (0.1 to 0.2 in.) broad. Seeds are flattened, brown, oval to nearly orbicular in outline, and margined, and range from 1.5 to 2.5 mm (0.1 in.) on the longest dimension (USFWS, 1996).

**Taxonomy**

Rollins (1955) considered L. lyrata to be an evolutionary link between L. densipila and L. auriculata, the somewhat closer relationship being with the former. Kral (1983) noted the close resemblance of L. lyrata and L. densipila, that the fruits of D. lyrata were slightly smaller and that both the fruit and the persistent styles are perfectly glabrous. McDaniel (1987) suggested that this difference, while consistent, was insufficient to justify recognition at the species level, and stated that assignment to varietal rank would be more appropriate. However, no worker has formally provided data to support such a change in taxonomic status (USFWS, 1996).

**Historical Range**

The current and historical distribution of D. lyrata is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama. (USFWS, 1996)

**Current Range**

The current and historical distribution of D. lyrata is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama. (USFWS, 1996)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

<u>Adult:</u> ~1 year (USFWS, 2009)

**Breeding Season**

Adult: March - April (USFWS, 2009)

**Reproduction Narrative**

Adult: The lyrate bladderpod is a winter annual with a long-lived seed bank. Flowering takes place usually from mid-March to April (USFWS, 2009).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Limestone outcropping/hill, glades (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Early successional habitats, disturbance (USFWS, 2009)

**Geographic or Habitat Restraints or Barriers**

Adult: Shading (USFWS, 2009)

**Environmental Specificity**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits red soils, limestone outcroppings and hills, disturbed cedar glades and glade-like areas (open pastures, cultivated fields, bottomlands, and roadsides in calcareous areas) (FNA 2010) (NatureServe, 2015). The lyrate bladderpod appears to be an early successional species that historically colonized the shallow soils on or adjacent to cedar glade habitats. This species slowly disappears as the soil layer develops and other competing plants establish themselves (U.S. Fish and Wildlife Service 1996). Shading causes decreased vigor and death and decreases the number of seeds at the site (Baskin and Baskin 1998, 2000). Disturbance is needed primarily to remove competing vegetation and also to bring seeds to the soil surface for germination (Baskin and Baskin 2000, U.S. Fish and Wildlife Service 1990, 1996; Webb and Kral 1986). The need for ground disturbance to maintain populations is evidenced in the fact that the best populations are those that are subject to some type of recurring disturbance such as grazing, plowing, and mowing (USFWS, 2009).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2024)

**Number of Populations:**

3 (USFWS, 2019)

**Population Narrative:**

Currently, there are three sites in three different counties known for this species (USFWS, 2019). The species is limited to three populations in three counties in northwest Alabama. Two of the three populations are not protected and appear to be declining. The unprotected populations are located on disturbed remnants of cedar glades. Cedar glades have been fragmented by agriculture and development and mostly exist as remnants today (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Herbicide Use (USFWS, 1996)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/Loss of individual plants
**Narrative:** The use of pre-emergent herbicides on agricultural crops as well as the use of herbicides as part of road side/easement maintenance is listed as threat to this species (USFWS, 1996).

**Stressor:** Road improvement (USFWS, 1996)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Road improvement is listed a s a threat to this species (USFWS, 1996)

**Stressor:** Proposed rock quarry (USFWS, 1996)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of the 1996 Recovery Plan a proposed rock quarry was threatening the habitat of this species. It is unclear whether this quarry was ever developed (USFWS, 1996).

**Stressor:** Development/Urbanization (USFWS, 1996)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Development for commercial, industrial and housing are listed as a threat to this species (USFWS, 1996)

**Stressor:** Trash dumping (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Trash dumping has destroyed or negatively impacted this species habitat (USFWS, 2009).

**Stressor:** Woody succession (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat

**Narrative:** Lack of disturbance can result in competition (and shade) from invading perennials (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/Loss of individual plants
**Narrative:** There are no State laws in Alabama protecting the lyrate bladderpod and its habitat. Otherwise, protection is afforded to this species under Section 7 and Section 9 of the ESA. The majority of one of the populations is permanently protected and consistently managed due to its location in a Nature Conservancy preserve. An adjacent portion of this population is currently being managed for the lyrate bladderpod under a voluntary Wildlife Cooperative Extension Agreement (WCEA) until the year 2017 (Hurt 2008a). The management outlined in the WCEA has been beneficial for the species, however, it does not provide for the permanent protection and management of this site (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 8

**Delisting Criteria:**
Species will be considered for delisting when nine demonstrably secure and self-sustaining populations exist. A demonstrably secure population is defined as one for which legal protection and active, successful management have been established. A self-sustaining population is defined as a population that is shown by monitoring data to be reproducing and relatively stable for at least a 10-year period (USFWS, 1996).

**Recovery Actions:**

- Protect and manage known populations. Negotiate with State and local highway departments and landowners. Develop management plans for each population and site (USFWS, 1996).
- Search for new populations. Conduct searches for additional populations. Continue to re-examine historic occurrence localities. Search for potential relocation/establishment sites for possible use in the future (USFWS, 1996)
- Conduct ecological research. Conduct hybridization studies, studies on seedbank size and seed viability. Study germination relative to natural conditions and agicuultural practices (1996).
- Conduct long-term site and population monitoring. Implement population monitoring. Monitor management techniques and results (USFWS, 1996).
- Maintain seeds and plants ex situ. Maintain seeds and plants (USFWS, 1996).
- Provide information to the public. Conservation efforts with the greatest successes are those with the greatest amount of public support. Plans should be developed to disperse information on D. lyrata to the local public, particularly to agricultural landowners (USFWS, 1996).

- Continue management and monitoring on Lawrence County population (USFWS, 2009).
- Work to secure protection and implement appropriate management for all other populations, most likely through conservation easements (USFWS, 2009).
- Renew contact with State and county highway department to ensure proper protective measures are implemented for those areas where plants occur onto roadside rights-of-way (USFWS, 2009).
- Survey in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2009).
- Work with landowners to reintroduce some type of ground disturbance activity at historical sites during appropriate time of year and follow with survey of sites next flowering season (USFWS, 2009).
- Gather base-line data on all populations and initiate long-term monitoring as means to track population trends and evaluate management efforts (USFWS, 2009).
- Expand species' biology studies to include field experiments (USFWS, 2009).
- Ensure preservation of genetic material from all populations through long-term seed storage through coordination with USDA Seed Storage Laboratory in Fort Collins, Colorado (USFWS, 2009).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2009).
- Update recovery plan (USFWS, 2009).
- Recovery Priority Number: 8

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1996). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. These activities are recommended to support and promote recovery of lyrate bladderpod. Recovery Activities • Pursue protection of currently unprotected populations. o Work to renew landowner agreement for property adjacent to Prairie Grove Glade Preserve. o Work to renew contact with State and county highway departments to ensure proper protective measures are implemented for those areas where plants occur within roadside rights-of-way. • Conduct habitat management to control competing vegetation and promote population growth. • Work with landowners to reintroduce some type of ground disturbance activity at historical sites during appropriate time of year and follow with survey of sites next flowering season. • Continue surveys to locate additional populations. • Work with cooperators to expand ex situ (off-site) preservation of genetic material and produce plants for potential outplantings. • Create a management manual for landowners, farmers, and the local transportation departments. Monitoring and Research Activities • Gather baseline data on all populations and implement consistent and long-term monitoring of all populations to track population trends and evaluate management efforts. • Study efficacy and optimal application of various habitat management practices (e.g., mowing, herbicide, prescribed fire). • Define self-sustaining population (USFWS, 2024).

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# SPECIES ACCOUNT: *Lesquerella pallida* (White bladderpod)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/11/1987; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

White bladderpod is an annual member of the Brassicaceae or Mustard Family. The plant overwinters as a tap-rooted, leafy rosette, reaching a maximum height of two feet as an erect plant or may be spreading. The white flowers appear in April and May and are composed of four one-half inch long petals. It produces pea shaped "bladderpods" that enclose the seeds before dying as its harsh habitat dries in the summer heat. Seed set occurs from late May to early June and the dormant stage begins in July and usually last until October.

**Current Range**

White bladderpods are known to occur only on the Weches Outcrops of San Augustine County, Texas.

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Glades within pine-oak forests

**Environmental Specificity**

Adult: Very Narrow (inferred from NatureServe, 2015))

**Habitat Narrative**

Adult: The white bladderpod occurs in natural openings or glades within pine-oak forests on shallow, stony, calcareous sandy loam or sandy clay loam over glauconite or ironstone of the Weches Formation; in addition, these glades are seep-moistened during the winter and spring but become desiccated during the summer (Poole et al. 2007, p. 378). White bladderpod population numbers are heavily influenced by local environmental conditions, such as winter or spring moisture and spring frost, as well as invasion of woody and herbaceous plants that tend to out-compete the white bladderpod.

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

Six extant or unknown abundance populations (USFWS, 2023).

**Population Size:**

112 - 10,000

**Population Narrative:**

Currently, there are eight known populations of the white bladderpod. Seven of the sites are located on private property, and the eighth site is located on private property and the adjacent road ROW of SH 21. Three of the populations were last surveyed in 2001 and found to have an extant population, four other populations were last surveyed in 2006 with extant populations, and the remaining population was surveyed in 2009 and found to have an extant population. White bladderpod population size varies drastically from year-to-year and appears to be due to differences in winter and spring moisture and spring frost or grazing by animals (Service 1992). The population numbers vary from 10,000 to 112 individual plants (see Table 1. for the most recent survey results for the known extant populations of the white bladderpod). Six extant or unknown abundance populations (USFWS, 2023).

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threats to white bladderpod are the invasion of woody and herbaceous plants into their limited habitat as well as overgrazing (Service 1992). Pasture improvement through the use of herbicides, plowing, and the introduction of non-native pasture grasses can destroy white bladderpod populations and habitat. Since all populations occur partly or wholly on private property, any major changes in land use are detrimental. In addition to home or other building construction, road construction is a threat to the populations of white bladderpod that occur within road ROWs. Rock quarrying poses a significant threat to the species since crushed rock from the Weches formation is used for gravel roads. Areas of suitable habitat within San Augustine County have already been lost to quarrying. Small populations could be prone to extirpation if a series of unfavorable years greatly reduces seed production and depletes the soil seed bank. Recolonization after a population has been lost would require long distance seed dispersal, which appears to be poor in white bladderpod (Service, 1992). )

**Stressor:** Surface Mining (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mining of glauconite minerals may continue to threaten the white bladderpod within its range. As described in the species 2014 5-year status review, “two EO IDs are located adjacent to a glauconite mine. There has not been an opportunity to survey the sites and therefore it is unknown whether or not these two populations have been impacted by the mining activities.” New glauconite mines in the area have not been developed, however glauconite mining is unregulated and therefore forecasting when and/or where these activities will appear on the landscape is extremely difficult. Mining of glauconite in the vicinity of occupied and suitable moist, alkaline habitat remains a potential threat to the white bladderpod (USFWS, 2023).

**Stressor:** Oil and Gas (USFWS, 2023)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Oil and gas development diminishes habitat quality and quantity through direct loss of habitat, introduction of nonnative species into modified areas of habitat, and an altered site hydrology. The white bladderpod is found atop glade habitats of East Texas's Hayensville Shale; since the white bladderpod can co-occur with the L. texana, (see the Texas golden gladecress SSA (Service 2022, pp. 41-44) for more detail). In San Augustine County in general, the majority of existing pipelines are located in the area north of State Highway (SH) 21 and west of the town of San Augustine. To the east of San Augustine, there are fewer pipelines, but of those that are located in this area, several are large gas transmission lines. The Railroad Commission of Texas (RRC) regulates the oil and natural gas industry in the state of Texas. The RRC has detailed information on all existing pipelines, but the agency has no way to predict future routes for new pipelines or wells. New pipelines and their routes are not displayed on the RRC website and although impacts from pipelines excavations could have an effect on the white bladderpod, specific locations of any future pipeline and any effects on the species and its suitable habitat are unknown. In addition to pipelines, associated oil and gas activities such as drilling and/or maintenance could also affect the white bladderpod and its habitat. Pipeline and well pad construction will continue to be a threat to the species as the demands for oil and gas production within San Augustine County continue. Since 2017, drilling permits issued by the RRC have generally increased over time and permits for 2023 are increasing (Figure 1; RRC 2023). In addition, projects that do not require consultation under Section 7 of the Act including maintenance and expansion associated with oil and gas wells, pads, roadways, etc. are occurring within existing known occupied sites of the white bladderpod. Since a federal nexus is often lacking in these cases, any coordination with the Service is not required (USFWS, 2023)

**Stressor:** Development – Transportation Projects (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** ROW that is managed by TxDOT. Observations from past site visits and TxDOT's online Project Tracker application as of April 2023, show resurfacing projects "underway or beginning soon" along SH 21 both east and west of the towns of San Augustine. On the west side of this town in the stretch of SH 21 where EO ID 12396 is located, the project is marked as ongoing. TxDOT is aware of the plants' presence and is avoiding the EO ID. Additional areas of exposed Weches glades occur within the ROWs within San Augustine County, but as of August 2023 none have been occupied by the white bladderpod (USFWS, 2023).

**Stressor:** Climate Change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is anticipated that effects from climate change could impact white bladderpod. The species is known from a single county known for its climatic extremes of temperature and precipitation (TNC 2003, ii; Diggs et al. 2006, p. 80) and native flora are well adapted to the region. White bladderpod is an edaphic (soil) specialist, restricted to soils with alkaline sediments with unique mineral and water retention properties described as seepy and saturated during the cool moist winter and spring months and dry during the summer (USFWS 1992, p. 4). These features may restrict the plant's capacity to spatially shift into surrounding habitat in response to

a changing climate (USFWS 2014, p. 15). Warnock (1992) documented the effects of its restricted nature with a high variability in population counts, attributing fluctuations to early year frosts and dry springs. The localized effects of climate change on white bladderpod are unknown, however The Intergovernmental Panel on Climate Change (2014, p. 26) projects that temperatures and the intensity and duration of heat waves will increase, which could make these populations less stable and persistent into the future (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2

**Recovery Actions:**

- The Recovery Plan requires the establishment of 12 self-sustaining populations of white bladderpod and the establishment of agreements for the protection and management of these populations in order to downlist the species from endangered to threatened. The Recovery Plan calls for the protection and management of the populations and habitat, the gathering of biological information necessary for management, establishing a botanical garden population, the search for new populations, and the establishment of new populations as necessary to meet downlisting criteria (Service, 1992). For more detailed information regarding recovery actions for the white bladderpod, please refer to White Bladderpod (Lesquerella pallida) Recovery Plan (Service 1992) (Recovery Plan). Shrub removal from three privately owned white bladderpod sites in 1995 proved to be beneficial, resulting in more plants being present the following spring. However, ongoing brush control is necessary to maintain suitable habitat at these sites. Three seed propagation facilities have been established and maintained, and the Nature Conservancy of Texas has developed a "Conservation Area Plan for the San Augustine Glades" under a Cooperative Agreement with the Service.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Future actions to aid in the recovery of the white bladderpod should focus on the implementation of the following actions: • Contact the land stewards and managers of all white bladderpod sites. • Work with land stewards to develop and implement management beneficial for the bladderpod. • Continue monitoring and surveys of known populations. • Implement projects and agreements through the Traditional Section 6 program with TPWD, the Service's PFW Program, as well as cooperative agreements with state and federal agencies. • Continue to search for additional populations. • Continue reintroduction efforts. Implement a reintroduction program, adhering to the Service's Controlled Propagation and Reintroduction Policy. • Acquire new conservation agreements with interested parties. • Continue conservation and recovery awareness through public and land steward outreach (USFWS, 2023).

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# SPECIES ACCOUNT: *Lesquerella perforata* (Spring Creek bladderpod)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/23/1996; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A herbaceous annual, stems several to many, outer ones usually decumbent (a plant that has its base lying on the ground and a stern that grows upward) at base, inner ones erect, simple or branched, 10 to 15 cm tall, stems and leaves are covered with fine or coarse hairs. Leaves at the base (rosette) have a petiole (leafstalk) and are lyrately (several lobes, which increase in size toward one large terminal lobe) lobed with pointed teeth on the margins. The stem leaves are sessile (stalkless and attached directly at the base), auriculate (ear shaped), oblong to obovate (egg shaped), with few to many teeth on the margins. The cross-shaped flowers are arranged in a raceme (stalked flowers arranged singly along an elongated unbranched axis), have white to pale lavender petals with a yellow base, and are 7 to 9 mm long. The fruits, or pods, are broadly obovoid (egg shaped) to pear-shaped, very inflated, 4 to 7 mm long, and divided into two halves. The outer surface of the pod is papery with very sparse hairs and the inside is densely hairy. The septum (the internal partition between the two halves) is perforated or nearly absent with only a small portion attached to the fruit wall. There are up to 10 round seeds in a pod measuring 1.5 to 2.5 mm long, strongly flattened and surrounded by a thin margin (USFWS, 2006)..

**Taxonomy**

Lesquerella is a genus of the Brassicaceae, the mustard family, named for the seventeenth century Swiss and American botanist Leo Lesquereux. There are approximately 75 taxa of Lesquerella with the majority occurring in the western states; only a few taxa are found in the Interior Low Plateau of Tennessee, Alabama, and Kentucky (Al-Shehbaz 1987). Only one species, Lesquerella lescurii (Nashville mustard), had been described in the eastern states prior to the 1950's work of Dr. Reed C. Rollins, a Harvard University expert on the Brassicaceae. From 1952 to 1955, Rollins described three new species of Lesquerella endemic to the Central Basin of Tennessee, L. densipila (Duck River bladderpod), L. stonensis (Stones River bladderpod), and L. perforata (Spring Creek bladderpod) (USFWS, 2006).

**Historical Range**

See current range/distribution.

**Current Range**

Known only from Wilson County, Tennessee (USFWS, 2006).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature (USFWS, 2006).

**Reproduction Narrative**

Adult: Lesquerella perforata is an annual that germinates between September and early October, overwinters as a small rosette of leaves, and fully develops and flowers the following spring. Full sunlight is required for optimum growth. Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature. Germination can only occur when the correct temperature coincides with adequate moisture (Pearson 1967). Upon germination, the cycle starts over again. The seeds of L. stonensis can remain viable in the seed bank for at least 6 years, and perhaps those of L. perforata can do the same (Rollins 1955, Kral 1983, Baskin & Baskin 1990, Fitch 2004) (USFWS, 2006).

**Habitat Type**

Adult: Limestone outcrops (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: This species is found mainly where sites have been disturbed by flooding or by cultivation, and tends to occur in areas of full sun on well-drained soils, as well as (rarely) on limestone rock outcrops. Most historic and current occurrences are on flood plains, where periodic flooding removes encroaching grasses and woody plants. Also occurs in places where other types of disturbances "substitute," such as on annually cultivated bottom land fields (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: No information found.

***Population Information and Trends***

**Number of Populations:**

23 (USFWS, 2024)

**Population Size:**

Fluctuates widely from year to year (USFWS, 2006)

**Population Narrative:**

Known from four populations consisting of 13 extant sites in Wilson County, Tennessee. Three additional sites no longer support the species. (U.S. Fish and Wildlife Service 1996) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred by the low number of knownm populations and the specifici habitat requirements of this species. As of 2019, there are 23 extant occurrences of Spring Creek bladderpod. Of the extant occurrences, 8 are located within the Spring Creek watershed, 11 within the Barton's Creek watershed, and 4 within the Cedar Creek watershed. One occurrence (EO 35) was discovered on USACE lands in 2015. All other occurrences are located on privately or municipally owned land. Land management activities, compatible and otherwise, are a primary driver of trends in the species' distribution and abundance. Maintenance of fescue pasture or lawns and applications of winter cover crops and pre-emergent herbicides to agricultural fields are not conducive to annual germination, growth, and reproduction of Spring Creek bladderpod, but are prevalent land uses within the species' geographic range. Fragmentation is not known to be affecting the extant occurrences, but could become a significant threat if occurrences are extirpated as a result of development or changes in management of agricultural lands. (USFWS, 2019). The Spring Creek bladderpod is an annual plant endemic to Tennessee. The species currently occurs in only three HUC 12 watersheds in Wilson County, TN: Spring Creek, Barton's Creek, and Cedar Creek. Since the last status review, one additional occurrence of the species was discovered in the Spring Creek watershed, and one occurrence was designated as extirpated in the Barton's Creek watershed, resulting in a total of 23 extant populations across the range. The species primarily occurs on private land, with no management agreements currently in place (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Cropland conversion to pasture (USFWS, 2006)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The conversion of cropland to pastures that contain grasses (e.g.) fescue poses a threat because of competition and lack of annual disturbance (USFWS, 2006).

**Stressor:** Urbanization/Development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Those sites on private lands in the City of Lebanon, primarily in Barton's Creek drainage, remain at high risk of loss to urbanization (USFWS, 2011). This includes placing fill material on this species habitat and road building.

***Recovery***

**Reclassification Criteria:**

Spring Creek bladderpod will be considered for reclassification to threatened status when there are 15 protected occurrences, five of which are located within the floodplain of each of three creeks (Spring Creek, Barton's Creek, and Cedar Creek). These occurrences, located on either public or private land, must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a five-year period, with no less than 100 plants in any given year (USFWS, 2011).

Recovery Priority Number: 5.

**Delisting Criteria:**
Spring Creek bladderpod will be considered for delisting when there are 25 protected occurrences, with at minimum five occurrences located within the floodplain of each of the three creeks (Spring Creek, Barton’s Creek, and Cedar Creek). Each occurrence located on either public or private land must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a ten-year period, with no less than 100 plants in any given year (USFWS, 2011).

**Recovery Actions:**
- We have not met the criteria for reclassifying Spring Creek bladderpod to threatened. No occurrences are protected by conservation easement; though three are protected by non-binding cooperative management agreements. Spring Creek bladderpod abundance fluctuates considerably over time (Table 1). While 500 or more plants have been observed at most of the occurrences at some point in time, fewer than 100 have also been observed at most occurrences at some point in time (USFWS, 2011).
- Continued efforts to implement recovery actions identified in the species’ recovery plan, improve monitoring techniques, and refine guidance for managing Spring Creek bladderpod are necessary. Specific emphasis should be placed on determining whether additional occurrences exist in the Cedar Creek drainage, and efforts should be redoubled to work with private and municipal landowners to ensure long-term protection of known occurrences through conservation easements (USFWS, 2011).

***Conservation Measures and Best Management Practices:***
- Recommendations for Future Actions The Service should continue working with partners to implement recovery actions identified in the species’ recovery plan; in particular, attempts should be made to improve monitoring techniques and mapping of occurrences, search for new occurrences, protect habitat that can be owned or managed by a public entity in perpetuity, and work cooperatively with private and municipal land owners to manage habitat for the species. Emphasis should be placed on determining the current status of occurrences lacking current data, surveying for additional occurrences, establishing conservation easements with private and municipal landowners to ensure long-term protection of known occurrences, and cooperatively managing habitat with private and municipal land owners. The Service recommends carrying out the actions below in an attempt to achieve the recovery criteria for Spring Creek bladderpod: 1. Determine whether EOs 18, 24, and 25 are extant. If Spring Creek bladderpod is not found at these sites, they should be evaluated to determine whether habitat has been destroyed or could be restored by working cooperatively with willing land owners. Sites with restoration potential should be prioritized for determining whether landowners would be willing to cooperatively manage habitat for the species. Additional sites to prioritize for cooperative habitat management include EOs 17, 19, 20, 28, and 34. 2. Conduct annual monitoring, collecting data that can be used to determine whether the recovery standard (i.e., 5-year average of at least 500 plants with no less than 100 in any given year) has been met at a given EO. Sites that meet this standard should be prioritized for protection via land purchase, conservation easement, or cooperative management

agreement. 3. Protect extant occurrences by acquiring occupied parcels or establishing conservation easements or agreements with private, state, and federal partners. The site on USACE lands should be a priority for establishing a cooperative agreement, to ensure appropriate management and monitoring of Spring Creek bladderpod on federal lands. 4. Due to the difficulty of accessing private property, where occurrences are predominantly located, surveys to locate new occurrences should combine use of aerial imagery flown during the species' flowering period, drone surveys, and ground-based surveys (where landowner permission is granted) to accurately determine the extent of populations. Survey effort should be focused in the Cedar Creek watershed, the only watershed within the range of Spring Creek bladderpod where fewer than five occurrences, as required by recovery criteria, are known to exist. Where possible, surveys should target federal or state-owned properties. 5. Conduct experiments to determine whether removing and relocating topsoil containing the seed bank to a secure, protected location is an effective method for minimizing adverse effects of site destruction for development or other purposes. This practice should not at this time be considered avoidance of an adverse effect for purposes of Section 7 consultation, as this is an unproven method. If this practice is determined to be effective, prioritize the identification of watershed-based recipient sites for populations facing extirpation and proactively acquire lands in extant watersheds with this priority. (USFWS, 2019)

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Spring Creek Bladderpod Recovery Plan (Service 2006). Renewing recently expired conservation agreements and/or identifying landowners with which to develop new management agreements would be supportive of recovery criteria and recovery actions identified in the recovery plan. The priority 1 actions identified in the recovery plan (e.g. establishing protection goals for EOs, pursuing easement or conservation agreements with landowners, developing management plans for EOs, etc.) are still very relevant. Actively engaging partners, and exploring opportunities for new partnerships, to implement these actions could be helpful in reinvigorating conservation efforts. Implementing these actions may also be facilitated by working proactively with landowners to balance the needs of the species within a sustainable working landscape and/or in the context of increased development pressures (USFWS, 2024).

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# SPECIES ACCOUNT: *Lesquerella thamnophila* (Zapata bladderpod)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/22/1999; Southwest Region (R2)

**Physical Description**

Zapata bladderpod is a pubescent, silvery-green, herbaceous perennial of the Brassicacea family, with sprawling stems 17 to 34 inches long. Basal leaves are narrowly elliptical to oblanceolate and acute, 1.5 to 4.8 inches long, and 0.3 to 0.6 inch wide, with entirely or slightly-toothed margins. Stems leaves are linear to narrowly elliptical and acute, 1 to 1.5 inches long and 0.1 to 0.3 wide, and have entire or slightly toothed margins. Cauline or stem leaves are linear to narrowly elliptical and acute, 3 to 4 cm (1 to 1.5 in) long and 2 to 8 mm (0.1 to 0.3 in) wide, with margins similar to basal leaves. The presence of stellate trichomes (small hair-like structures) on the leaves produces the plant's appearance of a whitish or silvery-green color. The inflorescence is a loose raceme of bright, yellow-petaled flowers. The flowers appear throughout the year depending upon temperature and rainfall, and are arranged along an axis with the lower flowers maturing first. Fruits are round and 4.5 to 6.5 mm (0.2 to 0.8 in) in diameter on short, downward curving pedicels (Poole 1989). (USFWS, 2004)

**Taxonomy**

Zapata bladderpod was first described as Lesquerella thamnophila Rollins and Shaw, based on specimens collected in Starr and Zapata counties (now EOs 1, 2, and 3) (Rollins and Shaw 1973). Al-Shehbaz and O'Kane (2002), citing molecular, morphological, cytological, biogeographic, and ecological data, transferred 91 taxa of Lesquerella to Physaria, including P. thamnophila. Genetic analyses, based on DNA sequences of the internal transcribed spacer of nuclear ribosomal DNA and length variation of inter-simple sequence repeat regions, revealed that Physaria, as previously recognized, was nested within and evolved more than once from Lesquerella. The former genus was polyphyletic, and the latter was paraphyletic. These authors united the two into a single monophyletic genus, conserving the earlier-published name of Physaria. This taxonomic revision is supported by the Flora of North America (O'Kane 2015), the Integrated Taxonomic Information Service (2015), Poole et al. (2007), and the Tropicos database (Tropicos 2015). (USFWS, 2015)

**Historical Range**

Starr and Zapata Counties, Texas.

**Current Range**

Starr and Zapata Counties, Texas. (USFWS, 2015)

**Critical Habitat Designated**

Yes; 1/22/2001.

**Legal Description**

On December 22, 2000, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 22, 2001) for Lesquerella thamnophila (Zapata bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in Texas (65 FR 81182-81212).

**Critical Habitat Designation**

The critical habitat designation for Lesquerella thamnophila includes eight CHUs in Starr County, Texas. This species critical habitat encompasses approximately 5,158 acres (ac) (2,088 hectares (ha)). Legal descriptions are presented below. Maps for general information purposes depicting the CH units are available in the Final Rule (65 FR 81182-81212).

Unit 1, Cuellar Tract (18 hectares (ha); 45 acres (ac))—(Segment 669). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by the National Geodetic Survey Triangulation Station ‘‘LABRA’’ (not found) having State plane coordinates of N = 331,881.065, E = 1,794,777.75. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard U.S. Fish and Wildlife Service (FWS) aluminum monument set for corner on the southeasterly line of Porcion No. 59 and the northeast corner of Share 35 and stamped ‘‘Tract 669, COR. No. 1, R.P.L.S. #4303’’ and having a State plane coordinate value of N = 320,083.51, E = 1,799,578.77, from which triangulation station ‘‘LABRA’’, bears N 22° 08' 38?W, 12,737.98 feet; thence, in a southwesterly direction along the common line of Porcion 59 and 60, S 54° 32' 24?W, 2,290.19 feet, to a standard FWS aluminum monument set for corner, being the common corner of Shares 35 and 26 and stamped ‘‘Tract 669, COR. No. 2, R.P.L.S. No. 4303; thence, in a northwesterly direction along the common line of Share 35 with Shares 26 and 27, N 35° 27' 36?W, 640.00 feet to a standard FWS aluminum monument set for corner, being the most southerly common corner of Shares 35 and 34 and stamped ‘‘Tract 669, COR. No. 3, R.P.L.S. No. 4303’’; thence, in a northeasterly direction along the common line of Shares 35 and 34; N 54° 32' 24?E, 2,290.19 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of shares 35 and 34 and stamped ‘‘Tract 669, COR. No. 4, R.P.L.S. No. 4303; thence, in a southeasterly direction along the common line of Shares 35 and 36 Parcel–A; S 35° 27' 36? E, 640.00 feet to the point of beginning and containing 33.648 acres of land. (Cuellar Tract—Segment 672). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by U.S. Fish and Wildlife Service GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set for corner on the common line between Porcions 59 and 60, and being the northeast corner of Share 26 and stamped ‘‘Tract 672, COR. No. 1, R.P.L.S. No. 3680’’ and having a State plane coordinate value of N = 318,737.64, E = 1,797,725.36, from which FWS GPS Monument No. 105 bears S 15° 22' 02? E, 7,920.94 feet; thence, in a southeasterly direction along the common line of Porcion 59 and 60, S 54° 27' 12?W, 806.50 feet to a standard FWS aluminum monument set for corner, being the southeast corner of said north one-half (1/2) of Share 26, same being the northeast corner of the south one-half (1/2) of Share 26 and stamped ‘‘Tract 672, COR. No. 2, R.P.L.S. No. 3680’’; thence, in a northwesterly direction along the common line of said north and south one-half (1/2) of Share 26; N 35° 27' 36? W, 463.31 feet to a standard FWS aluminum monument set for corner in the common line between Shares 26 and 27 and stamped ‘‘Tract 672, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northeast direction along the common line of Shares 26 and 27; N 54° 32Prime;; 24? E, 806.50 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of Shares 26 and 27 in the south line of Share 35 and stamped ‘‘Tract 672, COR. No. 4, R.P.L.S. No. 3680’’; thence, in a southeasterly direction along the common line of Shares 35 and 26; S 35° 27' 36? E, 462.09 feet to the point of beginning and containing 8.567 acres of land. (Cuellar Tract—Segment 673). Note: All bearings are based on the

Texas State Plane Coordinate System, South Zone, as referenced by FWS GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set for the common north corner of Shares 26 and 27, in the south line of Share 35 and stamped ‘‘Tract 672, COR. No. 4, R.P.L.S. No. 3680’’ and having a state plane coordinate value of N = 319,114.02, E = 1,797,457.29, from which FWS GPS Monument No. 105 bears S 16° 27' 21? E, 8,356.40 feet; thence, in a southwesterly direction along the common line of Shares 26 and 27, S 54° 32' 24? N, 806.50 feet to a standard FWS aluminum monument set for corner, being the southeast corner of said north one-half (1/2) of Share 27, same being the northeast corner of the south one-half (1/2) of Share 27 and stamped ‘‘Tract 672, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northwesterly direction along the common line of said north and south one-half (1/2) of Share 27; N 35° 27' 36? W, 592.30 feet to a standard FWS aluminum monument set for corner in the common line between Shares 27 and 28 and stamped ‘‘Tract 674, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northeasterly direction along the common line of Shares 27 and 28, N 54° 32' 24? E, 806.50 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of Shares 27 and 28 in the south line of Share 34 and stamped ‘‘Tract 674, COR. No. 2, R.P.L.S. No. 3680’’; thence, in a southeasterly direction along the common line of Shares 34 and 27, S 35° 27' 36? E, 592.30 feet to the point of beginning and containing 10.966 acres of land. (Cuellar Tract—Segment 672). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by FWS GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set replacing a 1–inch iron pipe found for the common north corner of Shares 28 and 29, in the south line of Share 33 and stamped ‘‘Tract 674, COR. No. 1, R.P.L.S. No. 3680’’; and having a state plane coordinate value of N = 320,078.90, E = 1,796,770.06, from which FWS GPS Monument No. 105 bears S 18° 47' 11? E, 9,484.36 feet; thence, in a southeasterly direction along the common line of Share 28 and Shares 33 and 34, S 35° 27' 36? E, 592.30 feet to a standard FWS aluminum monument set for corner, being the common northerly corner of Shares 28 and 27 and stamped ‘‘Tract 674, COR. No. 2, R.P.L.S. No. 3680’’; thence, in a southwesterly direction along the common line of said Share 28 and 27; S 54° 32' 24? W, 806.50 feet to a standard FWS aluminum monument set for the southeasterly corner of said north one-half (1/2) of Share 28, same being the northeasterly corner of the south one-half (1/2) of Share 28 and stamped ‘‘Tract 674, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northwesterly direction along the common line of the north and south one-half (1/2) of Share 28, N 35° 27' 36? W, 592.30 feet to a standard FWS aluminum monument set for corner in the common line between Shares 28 and 29 and stamped ‘‘Tract 674, COR. No. 4, R.P.S. No. 3680’’; thence, in a northeasterly direction along the common line of Shares 28 and 29; N 54° 32' 24? E, 806.50 feet to the point of beginning and containing 10.966 acres of land.

Unit 2, Chapeno Tract (28 ha; 69 ac)— (Chapeno Tract—Segment 660). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation Station ‘‘LABRA.’’ The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 02° 08' 43? W, a distance of 9,020.47 feet to the northwesterly boundary line of said 44.900-acre tract for the northmost corner of said Share No. 17 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 17 and the southwesterly boundary line of a 35-foot perpetual easement, S 32° 11' 36? E, 840.62 feet to the easternmost corner of said Share No. 17 and being corner No. 2 of this tract; thence, along the southeasterly boundary line of Share No. 17 and the northwesterly boundary line of Share No. 18, S 47° 29' 30? W, 293.59 feet to a said point on a fence line along the southwesterly boundary line of said 44.900-acre tract for the southernmost corner of said Share No. 17 and being corner No. 3 of this tract; thence, following said fence line along the southwesterly boundary line of Share No. 17 and the southwesterly boundary line of said 44.900-acre tract, N 30° 16' 28? W, 166.16 feet to a standard FWS aluminum monument stamped ‘‘Tract (660), R.P.S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 4 of this tract; thence, continuing along said fence line along the southwesterly boundary line of Share No. 17 and the southwesterly boundary line of said 44.900-acre tract, N 31° 04' 59? W, 684.02 feet to a standard FWS aluminum monument stamped ‘‘Tract (660), R. P. S. No. 4731’’ set for the westernmost corner of said 44.900-acre tract and being corner No. 5 of this tract, thence, following a fence line along the northwesterly boundary line of Share No. 17 and the northwesterly boundary line of said 44.900-acre tract, N 48° 42' 36? E, 273.46 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 661). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 00° 48' 20? E, a distance of 9,702.45 feet to the northernmost corner of said Share No. 18 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 18 and the southwesterly boundary line of Share No. 19, S 42° 40' 05? E, 623.01 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 18 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 18 and the southeasterly boundary line of said 44.900-acre tract, S 54° 58' 43? W, 14.82 feet to a standard FWS aluminum monument stamped ‘‘Tract (661), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 18 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 40? W, 442.61 feet to a standard FWS aluminum monument stamped ‘‘Tract (661), R. P. S. No. 4731’’ set for the southernmost corner of said 44.900-acre tract and being corner No. 4 of this tract; thence, following a fence line along the southwesterly boundary line of Share No. 18 and the southwesterly boundary line of said 44.900-acre tract, N 30° 16' 28? W, 581.86 feet to a point for the westernmost corner of said Share No. 18 and being corner No. 5 of this tract; thence, along the southeasterly boundary line of Share No. 17 and the northwesterly boundary line of Share No. 18, N 47° 29' 30? E, 329.16 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 662). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 00° 53' 22? E, a distance of 9,308.09 feet to the northernmost corner of said Share No. 19 and being corner No. 1 and the northernmost corner and the place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 19 and the southwesterly boundary line of Share No. 20, S 41° 14' 45? E, 941.54 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 19 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 19 and the southeasterly boundary line of said 44.900-acre tract, S 55° 22' 51? W, 8.49 feet to a standard FWS aluminum monument stamped ‘‘Tract (662), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 19 and the southeasterly boundary line of said 44.900-acre tract, S 54° 58' 43? W, 243.72 feet to the southernmost corner of Share No. 19 and being corner No. 4 of this tract; thence, along the northeasterly boundary line of Share No. 18 and the southwesterly boundary line of Share No. 19, N 42° 40' 05 W, 623.01 feet to a corner of Share No. 19 and being corner No. 5 of this tract; thence, along the northeasterly boundary line of a 35-foot perpetual easement and the southwesterly boundary line of Share No. 19, N 32° 08' 41? W, 293.64 feet to the westernmost corner of said Share No. 19 and being corner No. 6 of this tract; thence, along the southeasterly boundary line of a 35- ft. perpetual easement and the northwesterly boundary line of Share No. 19, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 663). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U. S. C. & G. S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 01° 55' 50? E, a distance of 9,166.26 feet to the northernmost corner of said share No 20, and being corner No. 1, and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 20 and the southwesterly boundary line of Share No. 21, S 44° 17' 45? E, 975.87 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 20 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 20 and the southeasterly boundary line of said 44.900-acre tract; S 55° 22' 51? W, 273.48 feet to the southernmost corner of Share No. 20 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 19 and the southwesterly boundary line of Share No. 20, N 41° 14’ 45’’ W, 941.54 feet to the westernmost corner of Share No. 20 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 20, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 664). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 03° 00' 15? E, a distance of 9,027.56 feet to the northernmost corner of said Share No. 21 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 21 and the southwesterly boundary line of Share No 22, S 46 ° 18' 57’’ E, 1,008.60 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of Share No. 21 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 21 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 56.04 feet to a standard FWS aluminum monument stamped ‘‘Tract (664), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 21 and the southeasterly boundary line of said 44.900-acre tract, S 55° 22' 51? W, 202.51 feet to the southernmost corner of Share No. 21 and being corner No. 4 of this tract; thence, along the northeasterly boundary line of Share No. 20 and the southwesterly boundary line of Share No. 21, N 44° 17' 45? W, 975.87 feet to the westernmost corner of Share No. 21 and being corner No. 5 of this tract; thence, along the southeasterly boundary line of a 35-foot perpetual easement and the northwesterly boundary line of Share No. 21, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 665). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station ‘‘LABRA,’’ having coordinate values: x = 1794,777.75, y = 331,881.06; thence, S 04° 06' 38? E, a distance of 8,892.12 feet to the northernmost corner of said Share No. 22 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of Share No. 22 and the southwesterly boundary line of Share No. 23, S 47° 33' 31? E, 1,036.06 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 22 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 22 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 245.67 feet to the southernmost corner of Share No. 22 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 21 and the southwesterly boundary line of Share No. 22, N 46° 18' 57? W, 1,008.60 feet to the westernmost corner of Share No. 22 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-foot perpetual easement and the northwesterly boundary line of Share No. 22, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 666). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y =331,881.06; thence, S 05° 15' 03? E, a distance of 8,710.10 feet to the northernmost corner of said Share No. 23 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of Share No. 23 and the southwesterly boundary line of said Share No. 24, S 48 ° 10' 23? E, 1,061.62 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of Share No.23 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 23 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 234.95 feet to the southernmost corner of Share No.23 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 22 and the southwesterly boundary line of Share No. 23, N 47° 33' 31? W, 1,036.06 feet to the westernmost corner of Share No. 23 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 23, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 667). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 06° 25' 32? E, a distance of 8,631.65 feet to the northeasterly boundary line of said 44.900-acre tract for corner No. 1 and the place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 51° 42' 47? E, 679.97 feet to a standard FWS aluminum monument stamped ‘‘Tract (667), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 2 of this tract; thence, continuing along the fence line along the northeasterly boundary line of Share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 01° 11' 48? E, 136.46 feet to a standard FWS aluminum monument stamped ‘‘Tract (667), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along the fence line along the northeasterly boundary line of Share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 54° 15' 17? E, 309.21 feet to a standard FWS aluminum monument stamped ‘‘Tract (667), R. P. S. No. 4731’’ set on a fence line for the easternmost corner of Share No. 24 and being on the southeasterly boundary line of said 44.900-acre tract and being corner No. 4 of this tract; thence, following said fence line along the southeasterly boundary line of share No. 24 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 197.94 feet to the southernmost corner of Share No. 24 and being corner No. 5 of this tract; thence, following said fence line along the southwesterly boundary line of Share No. 24 and the northeasterly boundary line of Share No. 23, N 48° 10' 23? W, 1,061.62 feet to the westernmost corner of Share No. 24 and northernmost corner of Share No. 23 and being corner No. 6 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 24, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land.

Unit 3, Arroyo Morteros Tract (41 ha; 102 ac)—Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by FWS GPS Monument No. 105 having State plane coordinates of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a 1/2-inch iron rod found for corner No. 1 on the common line between Porcions 59 and 60, and being the northwest corner of that certain 127.71-acre tract and having a State plane coordinate value of N = 315,746.07, E = 1,793,538.58, from which FWS GPS monument No. 105 bears S 53° 31' 49? E, 7,816.59 feet; thence, in a northeasterly direction along the common line of Porcion 59 and 60; N 54° 27' 12? E, 510.43 feet to a standard FWS aluminum monument set for corner replacing a 1/2-inch iron rod found, being the northwest corner of the herein described tract and stamped ‘‘Tract 670, Cor. No. 2, R. P. L. S. No. 3680’’; thence, in a easterly direction through the interior of said 536.485 acre tract; S 35° 20' 27? E, 3,621.01 feet to a standard FWS aluminum monument set for corner replacing a 1/2-inch iron rod found, being the northeast corner of the herein-described tract and stamped ‘‘Tract 670, Cor. No. 3, R.P.L.S. No. 3680’’; thence, in a southerly direction continuing through the interior of said 536.485 acre tract; S 61° 18' 54? W, 219.24 feet to a fence corner post found for a northwesterly corner of that certain 17.408 acre tract and being corner No. 4; thence, in a easterly direction along the common line between said 17.408 acre tract and the herein described tract; S 88° 47' 16? W, 110.41 feet to a fence post found for angle point and corner No. 5; thence, in a easterly direction continuing along said common line between a 17.408 acre tract and herein described tract; N 79° 11' 33? W, 67.63 feet to a fence post found for angle point and corner No. 6; thence, in a easterly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 71° 49' 04? W, 50.57 feet to a fence post found for angle point and corner No. 7; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 15° 40' 49? W, 44.43 feet to a fence post found for angle point and corner No. 8; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 00° 18' 59? E, 253.83 feet to a fence post found for angle point and corner No. 9; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 06° 36' 21? W, 182.88 feet to a fence post found for angle point and corner No. 10; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 26° 38' 19? W, 125.18 feet to a fence post found for angle point and corner No. 11; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 67° 33' 26? W, 129.76 feet to a fence post found for angle point and corner No. 12; thence, in a southerly direction continuing along said common line between a 17.408-acre tract and herein described tract; S 45° 58' 19? W, 73.00 feet to a fence post found for angle point and corner No. 13; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 35° 10' 19? W, 113.60 feet to a fence post found for angle point and corner No. 14; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 19° 34' 19? W, 42.80 feet to a fence post found for angle point and corner No. 15; thence, in a southerly direction continuing along said common line between a 17.408-acre tract and herein described tract; S 15° 23' 41? W, 28.84 feet to a 1/2-inch iron rod found on the apparent gradient boundary of the Rio Grande for the southeast corner hereof and corner No. 16; thence, in a westerly direction along said apparent gradient boundary of the Rio Grande; N 62° 26' 09? W, 81.47 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 7; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 36° 34' 14? W, 122.63 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 18; thence, in a northerly direction continuing along said apparent gradient boundary of the Rio Grande; N 20° 15' 10? W, 58.91 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 19; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 34° 02' 20? W, 118.95 feet to a point on said apparent gradient boundary of the Rio Grande for Corner No. 20; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 73° 36' 56? W, 17.73 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 21; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 43° 36' 30? W, 118.21 feet to a point on said apparent gradient boundary of the Rio Grande corner No. 22; thence, in a northerly direction continuing along said apparent gradient boundary of the Rio Grande; N 28°12' 58? W, 168.21 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 23; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 49° 09' 29? W, 149.82 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 24; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 66° 23' 26? W, 123.27 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 25; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 77° 18' 49? W, 240.49 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 26; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 80° 06' 32? W, 129.98 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 27; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 79° 54' 48? W, 218.17 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 28; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 81° 13' 28? W, 136.03 feet to a 1/2-inch iron rod found on said apparent gradient boundary of the Rio Grande for the southeast corner of the aforementioned 127.71 acre tract, same being the southwest corner hereof and corner No. 29; thence, in a northerly direction along the common line between said 127.71-acre tract and the herein described tract; N 06° 09' 33? W, 237.00 feet to a fence post found for angle point and corner No. 30; thence, in a northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 05° 51' 34? W, 198.49 feet to a fence post found for angle point and corner No. 31; thence, in a Northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 07° 49' 27? E, 161.97 feet to a fence post found for angle point and corner No. 32; thence, in a Northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 07° 47' 00? E, 302.39 feet to a fence post found for angle point and corner No. 33; thence, in a northerly direction continuing along the common line between said 127.71 acre tract and the herein described tract; N 07° 17' 37? E, 493.82 feet to a fence post found for angle point and corner No. 34; thence, in a northeasterly direction continuing along the common line between said 127.71-acre tract and the herein described tract, as fenced; N 46° 28' 41? E, 643.50 feet to a fence post found for angle point and corner No. 35; thence, in a northwesterly direction continuing along the common line between said 127.71 acre tract and the herein described tract; N 47° 51' 47? W, 1,087.49 feet to a fence post found for angle point and corner No. 36; thence, in a northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 21° 22' 25? W, 375.05 feet to the point of beginning and containing 89.90 acres of land.

Unit 4, Las Ruinas Tract (104 ha; 256 ac)—Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by National Geodetic Survey (NGS.) Triangulation Station ‘‘GORGORA’’ having State plane coordinates (NAD 27) of N = 275,335.73, E = 1.833,217.01. The scale factor used is 0.9999421, and the theta angle is -00° 16' 22?. All areas and distances are true surface measurements. Beginning at a 2- inch iron pipe having State plane coordinates of N = 280,488.40, E = 1,804,584.01 for the northerly southeast corner of the herein described tract, from which said triangulation station ‘‘GORGORA’’ bears S 79° 47' 55? E, a distance of 29,092.93 feet, same being the southwest corner of Share 96, of said Porcion 66, and the southwest corner of a 1455.52-acre tract of land as described, same being in the north line of Share 94, of said Porcion 66, same being in the north line of Tract ‘‘K’’, a 26.82-acre tract of land as described, for corner No. 1 and point of beginning of the herein described tract of land. Thence, westerly along the common line between said northerly line of tract ‘‘K’’ and the southerly line hereof N 80° 30' 29? W, 871.09 feet to a 6? iron pipe found for corner No. 2, same being the northwest corner of said Tract ‘‘K’’; thence, southerly along the common line between the westerly line of said Tract ‘‘K’’ and the easterly line hereof S 09° 22' 35? W, 837.18 feet, to a 13/4? iron pipe found for the southwest corner of said tract ‘‘K’’ and the northwest corner of a 23.5131-acre tract of land at corner No. 3, thence, southerly along the common line between said 23.5131-acre tract and the most southerly easterly line hereof, S 09° 22' 35? W, 540.00 feet to a standard FWS aluminum monument set, said monument being in the north line of a 56.82-acre tract of land as described for corner No. 4 and stamped ‘‘Tract 630, Ref. No. 4, RPLS 3680’’; thence, westerly along the common northerly line between said 56.82 acre tract and the southerly line hereof, N 80° 31' 16? W, 3295.18 feet to the apparent gradient boundary of the Rio Grande, and passing a standard FWS aluminum monument set for reference at a distance of 3,210.08 feet and stamped ‘‘Tract 630, Ref. No. 5, RPLS 3680’’; thence, northerly along the apparent gradient boundary of the Rio Grande N 63° 00' 17? E, 192.97 feet to a point on the apparent gradient boundary of the Rio Grande for Corner No. 6; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 62° 39' 49? E, 398.99 feet to a point on the apparent gradient boundary of the Rio Grande for Corner No. 7; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 60° 14' 39? E, 722.34 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 8; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 57° 28' 43? E, 416.75 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 9; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 57° 55' 40? E, 171.44 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 10; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 47° 49' 48? E, 287.44 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 11; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 43° 00' 00? E, 246.79 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 12; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 39° 40' 14? E, 295.08 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 13; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 35° 41' 43? E, 380.79 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 14; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 31° 28' 24? E, 370.58 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 15; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 33° 19' 15? E, 293.00 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 16; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 13° 43' 08? E, 146.31 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 17; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 11° 00' 57? E, 189.14 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 18; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 02° 10' 54? W, 305.51 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 19; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 01° 31' 51? W, 416.25 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 20; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 00° 01' 29? W, 441.45 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 21; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 03° 29' 26? E, 405.03 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 22; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 08° 08' 02? E, 308.09 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 23; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 39° 03' 01? E, 218.95 feet to a point on the apparent gradient boundary line of the Rio Grande, for corner No. 24 and northwest corner of this tract, same being the southwest corner of a 60.77-acre tract of land; thence, easterly along the common line between the south line of said 60.77- acre tract and the northerly line hereof S 80° 31' 16? E, 1942.92 feet to a standard FWS aluminum monument set and stamped ‘‘Tract 630, Ref. No. 25, RPLS 3680’’ for corner No. 25, same being the southeast corner of said 60.77- acre tract, same being in the west line of Share 339 of said Porcion 66, same being in the west line of said 1,455.52- acre tract of land, and passing a standard FWS aluminum monument set for Reference at a distance of 38.95 feet and stamped ‘‘Tract 630, Ref. No. 24, RPLS 3680’’; thence, southerly along the common line between the west line of said Share 339, Share 319, Share 227, Share 231, Share 230, Share 229, Share 518, Share 226, Share 225, Share 224, and said Share 96, same being the west line of said 1,455.52-acre tract and the east line hereof S 09° 28' 44? W, 3,845.12 feet and passing a 2-inch iron pipe found for the southwest corner of Share 339, same being the northwest corner of Share

319 at a distance of 315.48 feet, and being 0.46 feet easterly of and perpendicular to this line, and also passing a 1-1/2 inch iron pipe found for the southwest corner of Share 319, same being the northwest corner of Share 227 at a distance of 711.48 feet, and being 0.39 feet easterly of and perpendicular to this line, and also passing a 2-inch iron pipe found for the southwest corner of Share 231, same being the northwest corner of Share 230 at a distance of 1,320.71 feet, and being 0.09 feet easterly of and perpendicular to this line, to the point of beginning of the herein described tract and containing 254.42 acres of land.

Unit 5, Arroyo Ramirez Tract (273 ha; 675 ac)—Formal surveying of the tract has not been performed. Described as, ‘‘All of Share 79, Porcion 68, Abstract 191, Former Jurisdiction of Mier, Mexico, now Starr County, Texas, and all of Share 166, Porcion 69, Abstract No. 160, Former Jurisdiction of Mier, Mexico, now Starr County, Texas. Description by approximated latitude/ longitude coordinates (attached maps): Beginning at Latitude/Longitude 26° 24 00.9?N/099° 03' 23.9?W, westward to Latitude/Longitude 026° 24' 04.7?N/ 099° 03' 46.5?W, northward to Lat/Long 026° 24' 25.2?N/099° 03' 43.3? W, westward to Lat/Long 026° 24' 26.0? N/ 099° 03' 49.8? W, northward to Lat/Long 026° 25' 05.5? N/099° 03' 42.6? W, eastward to Lat/Long 026° 24' 56.6? N/ 099° 02' 40.3? W to the apparent gradient boundary of the Rio Grande River.

Unit 6, Los Negros Creek Tract (47 ha; 116 ac)—The following described tract of land is located in Starr County, Texas, about 1 mile northwest of the town of Roma, being 111.67 acres out of Share 13, Porcion 70, and being more particularly described as follows: Beginning at Cor. No. 1, an iron pin set for the northeast corner of Share No. 13 of Porcion No. 70 ; thence, along an old fence line and the dividing line between Share Nos. 13, 1–B and 12–A, S 09° 15' W, 2,694.00 feet to Cor. No. 2 an iron pin set on the Old High Bank of the Rio Grande and the southeast corner of this tract; thence leaving said fence line and along said Old High Bank with the following two courses, N 63° 17' 27? W, 1,161.54 feet to Cor. No. 3 and N 87° 10' 00? W, 612.00 feet to Cor. No. 4, a set iron pin and the southwest corner of this tract; thence leaving said Old High Bank and along the dividing line of Tract 2 and 3 of said Share 13 and an old fence line with the following three courses, N 09° 15' E, 841.30 feet to Cor. No. 5, a set iron pin; N 80° 45' W, 397.50 feet to Cor. No. 6, a set iron pin; and N 09° 15' E, 1,572.60 feet to Cor. No. 7 & iron pin set for the northwest corner of this tract; thence leaving said dividing line and along the north line of this tract and an old fence line, S 80° 45' E, 2,113.70 feet to Cor. No. 1 and the true place of beginning, containing 111.67 acres of land bounded on the West, North, and East by lands of unknown owner and on the South by the Rio Grande.

Unit 7, La Puerta Tract (1,577 ha; 3,895 ac) (Segment 590). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, as referenced by National Geodetic Survey (NGS) triangulation station ‘‘Fordyce 2’’ and NGS triangulation station ‘‘Monument’’. Scale factor used was 0.99993949; theta angle used was ¥00° 06' 15?. All areas are true ground measured areas. Beginning at corner No. 1, a standard U.S. Fish and Wildlife Service (FWS) aluminum monument stamped ‘‘TR 590 COR 1’’ set in the west boundary of Porcion 86, said point being at the southwest corner of the aforementioned 8,061-acre tract, and also being the northeast corner of a 160-acre tract recorded in volume 60, pages 47–48, Deed Records, Starr County, Texas, from which NGS triangulation station ‘‘Monument’’ bears N. 68° 59' 27? W, 8,477.20 feet; thence, from corner No. 1, along the western boundary line of said 8,061-acre tract and Porcion 86, N 09° 02' 27? E, 25,125.17 feet to corner No. 2, a standard FWS aluminum monument stamped ‘‘TR 590 COR 2’’, set at a fence corner from which NGS triangulation station ‘‘Monument’’ bears S 28° 34' 49? W, 24,795.18 feet; said corner No. 2 also being the northwest corner of the herein described tract, thence, from corner No. 2, departing said western boundary line, with fence, S. 78° 52' 36? E, 1,889.04 feet, to corner No. 3, a standard FWS aluminum monument stamped ''TR 590 COR 3'' set at fence corner; thence, from corner No. 3, continuing with fence, N 06° 16' 07? E, 1,007.99 feet to corner No. 4, a standard FWS aluminum monument stamped ''TR 590 COR 4'' set at fence corner; thence, from corner No. 4, continuing with fence, S 78° 42' 12? E, 2,691.33 feet to corner No. 5, a standard FWS aluminum monument stamped ''TR 590 COR 5'' set for angle; thence from corner No. 5, continuing with fence, S 72° 35' 38? E, 2,000.57 feet to corner No. 6, a standard FWS aluminum monument stamped ''TR 590 COR 6'' set at fence corner, said point being a perpendicular distance of 20.20 feet from the eastern boundary line of Porcion 87, said point also being the Northeast corner of the herein described tract; thence, from corner No. 6, continuing with fence, S 09° 01' 08? W, 10,831.38 feet to corner No. 7, a standard FWS aluminum monument stamped ''TR 590 COR 7'' set for angle adjacent to a found 5/8-inch iron pin; thence, from corner No. 7, continuing with fence, S 08° 56' 57? W, 10,030.04 feet, to corner No. 8, a standard FWS aluminum monument stamped ''TR 590 COR 8'' set for angle point, said point being at the intersection of said fence with the east boundary line of Porcion 87; thence, from corner No. 8, departing said fence, along the east boundary line of Porcion 87, S 09° 02' 27? W, 4,824.69 feet to corner No. 9, a standard FWS aluminum monument stamped ''TR 590 COR 9'' set for corner; thence, from corner No. 9, departing said east line, N 80° 47' 09? W, 6,527.80 feet to the place of beginning and containing 3,844.674 acres. (La Puerta 590a). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by the National Geodetic Survey (NGS) Triangulation Station ''Monument'' having a coordinate value of N = 250,167.56; E = 1,912,489.81. Scale factor applied equals 0.99993949; theta angle equals ¥00° 06' 15?. All areas are based on true ground measurements. Beginning at corner No. 1, a standard FWS aluminum monument stamped ''TR 590A COR 1'' set over a 2-inch iron pipe found in the west boundary line of Porcion 87, east boundary line of Porcion 86, at the northwest corner of said Lot 22, also being the northeast corner of a 2.83-acre tract as described by deed recorded in Volume 516, Page 62, Official Records, Starr County, Texas and being in the south boundary line of USA Tract (590) as described by deed recorded in Volume 608, Page 309, Official Records, Starr County, Texas said point having a coordinate value of N = 246,550.96; E = 1,923,962.74 and bearing S 72° 30' 13? E, 12,029.47 feet from NGS Triangulation Station ''Monument''; thence from corner No. 1, with south boundary line of said USA Tract (590), the north boundary line of said Lot 22, S 80° 47' 09? E, 2,922.00 feet to corner No. 2, a standard FWS aluminum monument stamped ''TR 590 COR 9'' found at the southeast corner of said USA Tract (590), also being the northeast corner of said Lot 21, and being in the east boundary line of Porcion 87, west boundary line of Porcion 88 for the northeast corner of the herein-described tract of land; thence, from Corner No. 2, with the said east boundary line of Porcion 87, west boundary line of Porcion 88, and also being the east boundary line of said Lot 21, S 08° 18' 30? W, 1,130.60 feet to corner No. 3, a standard FWS aluminum monument stamped ''TR 590A COR 3'' set in the existing north right-of-way line of U.S. Highway 83 with the intersection of said east boundary line of Porcion 87, west boundary line of Porcion 88 for the southeast corner of the herein described tract of land; thence, from corner No. 3, with and along the said existing north right-ofway line of U.S. Highway 83, N 66° 14' 23? W, 18.20 feet to corner No. 4, a standard FWS aluminum monument stamped ''TR 590A COR 4'' set for an angle point; thence, from corner No. 4, continuing along said existing north right-of-way line, N 60° 31' 23? W, 100.39 feet to corner No. 5, a standard FWS aluminum monument stamped ''TR 590A COR 5'' set for an angle point; thence, from corner 5, continuing along said existing north right-of-way line, N 66° 14' 23? W, 499.97 feet to corner No. 6, a standard FWS aluminum monument stamped ''TR 590A COR 6'' set for an angle point; thence, from corner No.

6, continuing along said existing north right-of-way line, N 71° 57' 23? W, 100.39 feet to a corner No. 7, a standard FWS aluminum monument stamped ‘‘TR 590A COR 7’’ set for an angle point; thence, from corner No. 7, continuing along said existing north right-of-way line, N 66° 14' 14? W, 1,084.94 feet to corner No. 8, a 5/8-inch iron rod found at the intersection of the said existing north right-of-way line with the proposed north right-of-way line of U.S. Highway 83; thence, from corner No. 8, departing said existing north right-of-way line with and along the proposed north right-of-way line of U.S. Highway 83, N 60° 43' 04? W, 200.90 feet to corner No. 9, a 5/8-inch iron rod found for an angle point; thence, from corner No. 9, continuing along said proposed north right-of-way line, N 69° 54' 31? W, 300.83 feet to corner No. 10, a 5/8-inch iron rod found at the intersection of said proposed north right-of-way line with the existing north right-of-way line of U.S. Highway 83; thence, from corner No. 10, with the said existing north right-of-way line of U.S. Highway 83, N 66° 16' 51? W, 399.70 feet to corner No.11, a standard FWS aluminum monument stamped ‘‘TR 590A COR 11’’ set over a 1/2-inch iron rod found for an angle point; thence, from corner No. 11, continuing along said existing North right-of-way line, N 64° 31' 54? W, 335.45 feet to corner No.12, a standard FWS aluminum monument stamped ‘‘TR 590A COR 12’’ set at the intersection of said existing north rightof-way line with the west boundary line of Porcion 87, east boundary line of Porcion 86; thence, from corner No. 12, departing said existing north right-ofway line with the said west boundary line of Porcion 87, east boundary line of Porcion 86, N 08° 56' 59? E, 357.90 feet to corner No.1, the point of beginning and containing 50.033 acres of land. (La Puerta Tract—Segment 590b). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by the National Geodetic Survey (NGS) Triangulation Station ‘‘Monument’’ having a coordinate value of N = 250,167.56' E = 1,912,489.81. Scale factor applied equals 0.00003040; theta angle equals ¥00° 06' 15?. All areas are based on true ground measurements. Beginning at corner No. 1, a 5/8-inch iron rod found at the intersection of the west boundary line of Porcion 87, east boundary line of Porcion 86 with the proposed south right-of-way line of U.S. Highway 83, said point bears S 08° 57' 33? W, 139.55 feet from a 5/8-inch iron rod found in the existing south right-of-way line of U.S. Highway 83, said point having a coordinate value of N = 245,880.85, E = 1,923,857.21 and bearing S 69° 20' 18? E, 12,148.81 feet from NGS Triangulation Station ‘‘Monument’’; thence, from corner No. 1, with the said proposed south right-of-way line, S 66° 14' 23? E, 3,043.33 feet to corner No. 2, a 5/8-inch iron rod found at the intersection of the east boundary line of Porcion 87, the west boundary line of Porcion 88 and the said proposed south right-of-way line, thence, from corner No. 2, with the said east boundary line of Porcion 87, west boundary line of Porcion 88, S 08° 59' 29? W, 2,925.70 feet to corner No. 3, a standard FWS aluminum monument stamped ‘‘TR 590B COR 3’’ set over a 1/2-inch iron rod found at the intersection of said east boundary line of Porcion 87, west boundary line of Porcion 88 with the north right-of-way line of the MissouriPacific Railroad; thence, from corner No. 3, with the said north right-of-way line of the Missouri-Pacific Railroad, N 52° 58' 07? W, 3,333.49 feet to corner No. 4, a standard FWS aluminum monument stamped ‘‘TR 590B COR 4’’ set over a 3/8-inch iron rod found at the intersection of the said north right-ofway line with the said west boundary line of Porcion 87, the east boundary line of Porcion 86, said point also being the southeast corner of a 39.492-acre tract, thence from corner No. 4, with the said west boundary line of Porcion 87, east boundary line of Porcion 86, N 08° 56' 13? E, 1,715.55 feet to corner No. 5, a standard FWS aluminum monument stamped ‘‘TR 590B COR 5’’ set over a 1/2- inch iron rod found at the southeast corner of a 2.0-acre tract, thence, from corner No. 5, continuing along said west boundary line of Porcion 87, east boundary line of Porcion 86, N 09° 08' 05? E, 418.93 feet to corner No. 1, the point of beginning and containing 170.950 acres of land.

Unit 8-Private ranch site comprises 0.552 hectares (1.36 acres) within the Universal Transverse Mercator, Zone 14 and begins at UTM 490706 E, 2929709 N; thence to 490729 E, 2929706 N; to 490748 E, 2929720 N; to 490762 E, 2929722 N; to 490767 E, 2929704 N; to 490767 E, 2929679 N; to 490769 E, 2929654 N; to 490770 E, 2929637 N; to 490770 E, 2929629 N; to 490760 E, 2929619 N; to 490743 E, 2929614 N; to 490732 E, 2929612 N; to 490720 E, 2929614 N; to 490709 E, 2929670 N; and thence to point of beginning.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lesquerella thamnophila critical habitat consists of three components (65 FR 81182-81212):

(a) Arid upland habitats of various soil types, including highly calcareous sandy loam to loamy sand, with low to moderate salinity levels on low sloping hills;

(b) Absence of substantial previous soil disturbance and seeding or sodding of exotic grasses; and

(c) A sparse overstory of shrub species typical of the Tamaulipan biotic province, but lacking a complete canopy as might be provided by a continuous overstory dominated by mesquite (Prosopis glandulosa).

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowers February - April, peaks in March (USFWS, 2024)

**Key Resources Needed for Breeding**

Adult: Insect pollinated

**Other Reproductive Information**

Adult: Zapata bladderpod receives a range of pollinator visitors such as beetles, various flies, bees, and wasps. Rainfall in this hot, semi-arid region occurs most reliably from September through November. Seed germination and the emergence of basal rosettes from dormant caudices probably occur in the fall and early winter in response to rain, cooler weather, and shorter day lengths (Service 2015, p. 6). Flowering occurs mainly from February to April, with a peak in March; flowering has occasionally been observed as late as October and as early as January (Middleton et al. 2024, p. 250). Most fruiting has been observed in March and April (Service 2015, p. 5). Usually, there are four seeds in each of the two chambers (8 seeds per capsule) but there are sometimes as many as 10–11 seeds per capsule (USFWS, 2024)

**Reproduction Narrative**

Adult: Zapata bladderpod blooms from April through September and produces bright yellow flowers. Plants will bloom throughout most of the year with adequate temperature and rainfall. Fruits are round, 0.2 to 0.8 inch in diameter, and are on short, downward curving pedicels (Poole 1989). Zapata bladderpod is known to be opportunistic, with the density of Zapata bladderpod plants and size of populations fluctuating with temperature levels and amount of rainfall. Zapata bladderpod is a perennial plant that sprouts above ground levels and produces stems more readily during periods of favorable weather. It can respond dramatically to rainfall events and increase from small, barely-detectable above-ground plants, to thousands of plants (USFWS 2004).

**Habitat Type**

Adult: Shrublands

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2004)

**Habitat Narrative**

Adult: Zapata bladderpod is endemic to South Texas, where it occupies cenizo and/or guajillo (Acacia berlandieri) shrublands. It can occur on graveled to sandy-loam, upland terraces above the Rio Grande flood plain. The soils on which the species is known to occur vary depending on location. In Starr County, documented populations occur within the Jimenez-Quemado soil association and on Catarina series soils. In Zapata County, they occur within the Zapata-Maverick soil association and may also occur within the Copita-Zapata soils (USFWS 2004). Zapata bladderpod may occur within areas of sparse vegetation or under canopy of associated shrub species. The shrub species may serve as nurse plants for Zapata bladderpod, potentially reducing the amount of sunlight on the soil surface and helping to maintain moisture in the root area. Adjacent shrubs also provide protection from soil erosion and may serve as a deterrent to browsing animals. Associated plants include mesquite, granjeno, Spanish dagger (Yucca treculeana), lotebush, guayacan (Guaiacum angustifolium), cenizo (Leucophyllum frutescens), and blackbrush (Acacia ridgula) (USFWS 2004).

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

12 populations, 19,770 total acres.

**Population Size:**

>200,000 total

**Additional Population-level Information:**

a total of 12 known populations monitored within Starr and Zapata counties, estimated population sizes collected from 2022-2024-indicate that most populations have experienced declines (see Table 1). Of the six populations with confirmed population declines, five have experienced substantial reductions (31 to 99%) in the number of individuals documented compared to the high ever documented, and only two populations currently meet the MVP of at least 2,000 individuals. (USFWS, 2024)

**Population Narrative:**

The recovery plan stated that there are 7 extant populations, while the TXNDD now lists 8 extant populations and two of unknown status. Of the latter, EO 2 is a historic record north of Roma for which the precise location is unknown. EO17 was detected during a survey of private land in 1994, also north of Roma, and the site has not since been re-visited. The recovery plan also states that there are 11 documented occurrences, but this figure confounds known populations and designated areas of critical habitat. We believe the EOs reported by TXNDD correctly represent our current knowledge of the populations and distribution of Zapata bladderpod. (USFWS, 2015) Four of the seven populations known historically to occur in Starr County still support Zapata bladderpod plants (USFWS 2004). Two of these seven are in the highway ROWs between Zapata and Falcon, and one on private property in Siesta Shores subdivision. The populations that occur on the LRGV NWR tracts in Starr County continue to maintain the largest number of plants (USFWS 2004). Three refuge tracts and the private ranch have fairly large populations. These populations number in the thousands of individuals in rainy years but occur within a very restricted area covering only a few acres (Best 2006, personal comm.). In Zapata County, three of the four historically documented sites still support Zapata bladderpod. The predominance of private lands in South Texas limits access for surveys, therefore the species range may be more extensive than what is currently known. The size of populations fluctuates depending on rainfall and weather cycles increasing the difficulty in locating the plants (USFWS 2004).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** • Buffelgrass is more prevalent in disturbed soils; not highly competitive in Zapata bladderpod habitat. • Soils are extremely prone to erosion. Root- plowing and other forms of soil disturbance exacerbate erosion. • Overgrazing increases soil erosion. • Foot and ATV traffic associated with border security destroys plants by trampling and leads to soil erosion. • Rapid local population growth, highway construction between Laredo and Rio Grande City. • Petroleum development and pipeline construction continues at rapid pace. (USFWS, 2015)

**Stressor:** The inadequacy of existing regulatory mechanisms (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Endangered Species Act (ESA) does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the three populations on tracts of Lower Rio Grande Valley NWR. However, as described above, Endangered Species Act provisions, including section 7 consultation, can be waived by DHS to expedite construction of border barriers. Federally-listed plants occurring on private lands have very limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Therefore, Zapata bladderpod populations and habitats on private land are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project. (USFWS, 2015)

**Stressor:** Other natural or man-made factors affecting its continued existence (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** • Some EOs within developed areas or along highway ROWs are vulnerable. • Periodic vegetation shredding along utility ROWs may have beneficial effect, provided that soil is not disturbed. • Small isolated populations subject to genetic drift and inbreeding. • Historic conversion of shrub savanna to dense shrubs and cessation of wildfire may have affected populations. • Potential impacts of climate changes. (USFWS, 2015)

***Recovery***

**Reclassification Criteria:**
1. Maintain or establish 12 geographically distinct, self-sustaining populations located within the species' historical range in the United States, with at least one population in each of the 3 geologic formations from which the species is currently known to occur. Each population should consist of at least 2,000 reproductive individuals (have flowered at least once or are capable of flowering) as determined during years when precipitation patterns have stimulated growth and reproduction. The numbers of reproductive individuals at each of the 12 population sites must be stable or increasing. (USFWS, 2019)

2. To count toward reclassification, all populations must be appropriately protected and actively managed to reduce or eliminate threats to the species. Agreements for the protection and appropriate management of the 12 self-sustaining populations must be in place. Perpetual protection on public land will be assured via Service-approved management plans (e.g. National Wildlife Refuge Comprehensive Conservation Plans). Formal stewardship agreements (e.g. conservation easements or similar instruments) must be in place to ensure perpetual long-term, species-appropriate management on privately-owned land. (USFWS, 2019)

Recovery Priority Number: 8C

**Delisting Criteria:**
1. Over a 30-year period following reclassification of the species to threatened, monitoring of 12 fully protected, self-sustaining populations consisting of at least 2,000 reproductive individuals per population shows that the populations are stable or increasing. These populations will be located within the species' historical range in the United States, with at least one population in each of the three geologic formations from which the species is currently known to occur.

2. Populations continue to be protected through perpetual management agreements. Threats to each population have been reduced or eliminated through appropriate site management that may include such actions as limiting erosion by excluding vehicles, foot traffic, and/or overgrazing by livestock, diminishing woody vegetation using means that do not disturb the soil, or potentially controlling invasion by non-native grasses. The effectiveness of this management would be determined by monitoring the condition of habitat and the status of the species' such that it is stable or increasing in number

**Recovery Actions:**
- 1. Protect known bladderpod populations in the United States. The known populations of Zapata bladderpod must be protected from habitat destruction or degradation and other relevant threats. Relationships with private landowners, soil conservation district agencies, roadway construction agencies, oil and gas exploration/production agencies, and rural development agencies should be developed to raise awareness of and conserve the habitat

where bladderpod populations are located. (USFWS, 2004)

- 2. Search for new populations. Surveys should be conducted to locate Zapata bladderpod populations in the United States and Mexico. Many areas of native habitat have not been surveyed for this species due to lack of access. This species is difficult to detect without an intensive search due to its ephemeral tendencies during drought conditions. Information on the Zapata bladderpod's appearance, rarity, and vulnerability should be provided to Federal, State, and private landowners. To ensure accuracy, surveys should be conducted at favorable times to locate the plants, (e.g., after rainfall) focusing on associated soil types. Federal (i.e. USFWS, USDA, etc.) and State (TPWD, TDA, etc.) agencies as well as non-governmental organizations (TNC) should increase efforts to form relationships with private landowners to search for and protect populations. (USFWS, 2004)
- 3. Conduct studies to gather information about Zapata bladderpod for management and recovery in the wild. Information on the ecology, life history, population biology, and pollination for the Zapata bladderpod in its native habitat is lacking. Efforts to understand and manage the species are therefore hindered. Studies conducted to gather basic biological information on the species should focus on factors that will enable a better understanding of habitat and provide insight into effective management for the species. Information obtained from the studies should be incorporated into management plans as appropriate to assist recovery of the species. New information should be incorporated into future recovery plan revisions. (USFWS, 2004)
- 4. Establish a botanical garden population and seed bank. Specimens from the known population(s) should be maintained at different institutions. A seed bank should be established for the species and maintained at the National Seed Storage Laboratory in Fort Collins, Colorado. The San Antonio Botanical Garden has indicated an interest in conducting research on propagation techniques and seedling production for the Zapata bladderpod, and to establish an educational botanical garden population (Cox 2002 pers. comm.). At least two refugia collections and seed bank reserves should be established and maintained to provide assurance against extinction if a loss of natural populations should occur. Cultivated plants could provide individual plants for research and provide a plant source for possible reintroductions. (USFWS, 2004)
- 5. Establish new populations as necessary to meet downlisting criteria. Due to the apparent rarity of the Zapata bladderpod within its range, reintroductions of the species may be necessary to aid recovery. The Service defines reintroduction as placing species in its historic range. As some of the collection data for this species is ambiguous, any reintroduction will need to be undertaken in areas of appropriate habitat within the historic range of the species. Reintroduction efforts could be implemented on Federal lands such as those within the LRGV Refuge Complex or on State or private lands volunteered for use. Any reintroduction efforts will follow Service policy on controlled propagation of endangered and threatened species, and incorporate the most recent reintroduction guidelines available (Falk et al. 1996). (USFWS, 2004)
- 6. Develop a public information and awareness program. Public awareness and cooperation are essential for the success of the Zapata bladderpod recovery program. An informative program about the Zapata bladderpod, threats to the species, the Recovery Plan, and the Endangered Species Act in general, should be developed for presentation to private landowners, agency personnel, and other interested groups. The program should include the identification of recovery tasks that the individuals or groups being addressed can accomplish to participate in recovery of the species. Additionally, information on the Zapata bladderpod should be included within any Lower Rio Grande or Mexico/United States Bi-

national Ecosystem program so that a coordinated approach to recovery can be implemented. (USFWS, 2004)

- 7. Develop delisting criteria and a post-recovery monitoring plan. Once the needed information on distribution, life history, ecology, and genetics are obtained, delisting criteria and a post-delisting monitoring plan can be developed. Future criteria should be developed that incorporate measures to alleviate threats identified under the five listing factors and identify when the species will no longer be threatened with endangerment. All information needs for Zapata bladderpod that have been determined as critical during the course of recovery-oriented research must be evaluated prior to delisting. If the downlisting criteria are no longer being met, the species should be returned to the status of endangered. Post-delisting monitoring for a minimum of five years is required by the ESA. (USFWS, 2004)
- Revise the recovery plan and recovery criteria to define both down-listing and de-listing criteria. (USFWS, 2015)
- Consider revising criteria to allow larger numbers of smaller populations to contribute to recovery; use frequency of recruitment as a measure of demographic trends. • Conduct public outreach in Starr and Zapata counties to raise local awareness of Zapata bladderpod. Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6funded grants, cooperative efforts with Natural Resources Conservation Service, or nongovernmental partners. Establish a private landowner support group for conservation of Zapata bladderpod (and perhaps other plant species of concern known from that region), similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus). (USFWS, 2015)
- Support scientific investigation of the reproductive biology and pollination, genetic structure of the wild populations, response to shrub cutting and prescribed burning, and degree of tolerance or requirement for gypsum (gypsovagy versus gypsophily). (USFWS, 2015)
- Prohibit vehicle traffic, including ATVs, from Zapata bladderpod occupied habitats at LRGV NWR, and limit foot traffic to the greatest extent possible. (USFWS, 2015)
- Develop a potential habitat model based on geological and soil factors. Conduct expanded surveys based on this model on private lands (with landowner permission) in Texas as well as Tamaulipas and Nuevo León (pending the resolution of security issues on the Mexican side of the border). (USFWS, 2015)
- Collect seeds from the most vulnerable populations, develop propagation methods, and reintroduce the propagated Zapata bladderpod plants into suitable protected habitats to create refugia for the vulnerable populations.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Continue public outreach in Starr and Zapata counties to raise local awareness of Zapata bladderpod and other listed plants, such as prostrate milkweed. Support conservation of wild populations on private lands with willing landowners through the Service's Partners for Fish and Wildlife Program, section 6 grants, cooperative efforts with Natural Resources Conservation Service, or non-governmental partners. Complete in-progress scientific investigations of the reproductive biology, seed ecology, and pollination of Zapata bladderpod. Implement findings from propagation experiments to repopulate priority areas using results from best management practices currently in development to increase germination and reduce seedling transplant mortality. Prohibit vehicle traffic, including ATVs, from Zapata bladderpod occupied habitats at National Wildlife Refuge tracts, and limit foot traffic to the greatest extent possible.

Continue to work with U.S. Customs and Border Protection and Texas Department of Transportation to avoid, minimize, and mitigate impacts. When possible, prioritize habitat protection and avoidance of impacts, rather than translocation of individuals from established populations. Relocation efforts and plant survival have so far had minimal success; therefore, until better methods are developed for translocation of plants, this practice should be used with caution and only as a last resort. (USFWS, 2024)

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# SPECIES ACCOUNT: *Lessingia germanorum (=L.g. var. germanorum)* (San Francisco lessingia)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A slender annual herb, mostly 1-3 dm tall. The flower heads have bright yellow disk flowers; they lack rays (NatureServe, 2015).

**Taxonomy**

Lessingia germanorum is the type species for its genus (the first plant selected by taxonomists to represent the group; the exemplar for all related species). San Francisco lessingia is currently considered a distinct species, it was formerly thought to be most closely related to Lessingia glandulifera A. Gray var. pectinata Jeps. (Howell 1929, S. Markos, pers. comm. 1998) (USFWS, 2003). It is a member of the aster family (Asteraceae) (USFWS, 2012).

**Historical Range**

Historically, L. germanorum occurred within central dune scrub habitats throughout the San Francisco peninsula. At the time of listing in 1997, Lessingia germanorum was restricted to the Presidio area of the San Francisco peninsula (five occurrences), and the Hillside Park occurrence in Daly City near the base of San Bruno Mountain (one occurrence) (USFWS, 2012).

**Current Range**

Currently the species is known to occur at seven locations in the Presidio (M. Chassé, National Park Service, in litt., October 26, 2011, p. 1;M. Chassé in litt., September 29, 2011) and at one occurrence near Hillside Park in Daly City (USFWS, 2012).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2012)

**Lifespan**

Adult: 1 year (USFWS, 2012)

**Breeding Season**

Adult: August - November (USFWS, 2012)

**Key Resources Needed for Breeding**

Adult: Insect pollinators (USFWS, 2012); wind (USFWS, 2003)

**Reproduction Narrative**

Adult: L. germanorum is an annual plant typically flowers between August and November. Spence (1964) determined that Lessingia species are generally self-incompatible (infertile when restricted to self-fertilization) making the presence of appropriate pollinators necessary for seed production. Information on California pollinators which was published in 1979 (Krombein et al. 1979), lists five species of native bees that visit the Lessingia germanorum. They include Andrena baeriae, Hoplitis productus gracilis, Anthophora urbana urbana, Exomalopsis nitens, and Ashmeadiella californica californica (Krombein et al. 1979, pp. 1799, 2018, 2026, 2118, and 2164) (USFWS, 2012). Reproductive output of individual plants is highly variable. Pogge (1998) found a range from 1 to over 1,400 flowerheads per plant, depending on plant size. Large plants in sparsely vegetated areas may produce many hundreds of flowerheads, each bearing up to 40 florets (potential seeds; Lane 1993), but actual average number of seeds per flowerhead is about 26 (Pogge 1998), implying that the largest individuals may produce up to 36,400 seeds. Pollination is possibly achieved by wind as well (Spence 1964) (USFWS, 2003).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Dune scrub (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Natural disturbance (USFWS, 2003)

**Geographic or Habitat Restraints or Barriers**

Adult: 80 - 300 ft. elevation (USFWS, 2012); dense vegeation (USFWS, 2003)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2003)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2012)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 2003)

**Habitat Narrative**

Adult: Inhabits dune scrub habitats; now restricted to remnant sand dunes and terraces (NatureServe, 2015). It grows in open areas with blowing sand at an elevation range between 24 to 91 m (80 to 300 ft). Most populations are found in vegetation gaps in stabilized old sand dunes or sandy soils derived from ancient sandy coastal deposits (USFWS, 2012). Spence (1964) observed that annual Lessingia species were typical of dry, open, and somewhat disturbed habitats, occurring in small, dense, disjunct populations. Nearly all historic collections of San Francisco lessingia with specific locality and habitat information have been made in areas with disturbed dune deposits. Undisturbed areas of dune scrub or nonnative grassland with high density and cover of vegetation show little tendency to become invaded by San Francisco lessingia, even when they are adjacent to source populations of this species (P. Baye, pers.

observ. 1997 to 1998). In contrast, San Francisco lessingia can spread vigorously under favorable climate conditions when extensive substrate disturbance occurs (USFWS, 2003).

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 2003)

**Dispersal/Migration Narrative**

Adult: The seeds, which are attached to a crown of hairlike bristles, are light and easily carried by the wind (USFWS, 2012). Seed dispersal distance has not been studied, but seedling distribution tends to be contagious around parent plants. Landscape barriers to dispersal, such as tree plantations, may be more significant barriers to dispersal than inherent dispersal ability of achenes. Seeds may also possibly be passively dispersed by humans, by adherence of seed to footwear or clothing (J. Cannon, pers. comm. 1997) (USFWS, 2003).

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

3 (USFWS, 2024)

**Population Size:**

Variable depending on year; 500,000 - 2,000,000 overall range (USFWS, 2003)

**Population Narrative:**

Currently, there are seven known occurrences at the Presidio and one population near Hillside Park. The occurrences on the Presidio occupy 2.4 ha (6 ac) and consist of an estimated mean of 129,133 plants (M. Chassé, in. litt., October 18, 2011, p. 2). In any given year, however, the area occupied and the numbers of plants will vary due to factors such as vegetation changes and levels of stewardship (M. Chassé, in. litt., October 18, 2011, p. 2). Approximately 300 plants were found in a portion of the Hillside Park occurrence in 2011 (T. Corelli, in litt., September 14, 2011). Research by Markos and Baldwin (2002) indicates that there is distinct genetic variation between the Presidio populations and the Hillside Park population (USFWS, 2012). The overall rangewide number of San Francisco lessingia plants, though highly fluctuating and quantified with variable accuracy and precision, ranges over a magnitude around 500,000 to 2,000,000 plants (USFWS, 2003). At the time of listing, San Francisco lessingia was known from the Presidio population (Occurrence 1) in San Francisco County and the San Bruno Mountain population (Occurrence 7) in San Mateo County (Service 1997, pp. 33368–33369; Diversity Database 2023, pp. 1, 6). Additionally, a population in the general vicinity of Lake Merced (Occurrence 4) had not been seen since 1947 and was considered “possibly extirpated” (Diversity Database 2023, p. 5). A population in the vicinity of Fulton Street (Occurrence 3) had not been observed since 1927 and was considered extirpated due to extensive development in the area (Diversity Database 2023, p. 4). The Crissy Field population (Occurrence 8) had been introduced to restored habitat in Crissy Field by unintentional seeding during the winter of 1999–2000 (Diversity Database 2023, p. 7). Unfortunately, reports from site managers over a nine-year period have consistently indicated the Crissy Field population has not persisted (Chassé and Forrestel 2014, p. 27; Chassé 2016, p. 31; Chassé undated (c), p. 21). Survey data for this population is included in Appendix 1, Table 2d. The Diversity Database currently categorizes the occurrence as “presumed extant” (Diversity Database 2023, p. 7). Currently, San Francisco lessingia occurs in three populations: Presidio, San Bruno Mountain, and Fort Funston (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Nonntaive plants and succession (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, nonnative annual grasses and forbs are still a threat to Lessingia germanorum on the Presidio; the most dominant nonnative grass within L. germanorum habitat is Bromus diandrus (M. Chassé, in. litt., October 18, 2011, p. 2). In the absence of disturbance, back dunes on the Presidio that are capable of supporting Lessingia germanorum go through a succession to stable dune scrub which does not support the species. Large scale projects that result in the removal of dune scrub will need to be considered to maintain the L. germanorum over time (M. Chassé, in. litt., October 18, 2011, p 3) (USFWS, 2012).

**Stressor:** Urbanization (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threats to L. germanorum from pedestrians, and hikers are considered to be low; digging dogs are a moderate threat. Since the time of listing, 0.3 acre of Lessingia germanorum habitat on the Presidio in the Lobos Dunes occurrence was adversely affected at the base of Landfill 10. Landfill 10 was in the process of remediation by the Presidio Trust when heavy rain storms in late 2009 and early 2010, eroded loose soil from the landfill, burying L. germanorum plants and habitat downslope. The owner of two parcels that support part of the Hillside Park occurrence recently submitted plans to the City of Daly City for development of a nine-lot subdivision, known as the Hillside Park Court Subdivision, on these parcels (J. Naughton, City of Daly City Planning and Zoning Department, pers. comm., December 6, 2011; K. McIntire, San Bruno Mountain Watch, in litt., November 29, 2011). In addition, a road to access the development is proposed to be constructed through a third parcel that is part of Hillside Park and is also occupied by L. germanorum (K. McIntire, in litt., November 29, 2011) (USFWS, 2012).

**Stressor:** Climate change (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. Although there is uncertainty on the effects of climate change on this species, the vulnerability of the species to significant shifts in climate is increased by the natural and artificial barriers to dispersal (M. Chassé, in. litt., October 18, 2011, p 3) (USFWS, 2012).

**Stressor:** Loss of pollinators (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat fragmentation increases the risk at all occurrences to reduced seedset from loss of pollinators. Two recent studies of bee diversity have been conducted at several sites in the Presidio (Wood et al. 2005, Van Den Berg et al. 2010). The study conducted in 2004 (Wood et al, 2005) established a baseline of species and numbers of bees found at nine sites on the Presidio. The study conducted in 2008 (Van Den Berg et al. 2010) resampled three of these sites and added a new previously unsampled site. A comparison of the results of the two studies at the three sites in common, Thompson Reach, Lobos Dunes (the site of a L. germanorum occurrence), and the World War II Memorial, revealed a number of differences between the studies. Overall, the average bee species richness and abundance at the three previously samples sites were greater in 2004 with 47 species and 1,283 individuals compared to 36 species and 878 individuals in 2008 (Van Den Berg et al. 2010, p. 4). At the World War II Memorial site; however, a different trend was observed in 2008. Bee diversity increased from 15 species in 2004 to 26 species in 2008 although five species including the common bumblebee, Bombus vosnesenskii, had declined dramatically. Abundance of bees at this site more than doubled from 192 individuals in 2004 to 391 in 2008 (Van Den Berg et al. 2010, p. 5). The identity of the plants being visited by the pollinators monitored in these studies was not recorded (USFWS, 2012).

***Recovery***

**Reclassification Criteria:**
1. Long-term expansion of existing populations and reduction of nonnative vegetation occurs in dune reserves in the Presidio Recovery Unit (Lobos Creek, Battery Caulfield, Wherry, Rob Hill, and Public Health Services Hospital sites). The populations in these reserves are expected to fluctuate but should not decline below 50,000, 1,000, 5,000, 5,000, and 5,000, respectively. Cover of nonnative vegetation in these reserves should be less than 5 percent, 20 percent, 5 percent, 20 percent, and 20 percent, respectively. Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

2. The population of the Daly City reserve shows no net long-term decrease. Populations are expected to fluctuate but should not decline below 50,000 plants. Cover of nonnative vegetation should show no progressive increase over more than 2 years (USFWS, 2012).

3. Recreation management needs for maintenance of a dune scrub community in the Fort Funston Reserve are established through sitespecific studies, and a reintroduced population has persisted over a full precipitation cycle. The population is expected to fluctuate but should achieve a minimum self-sustaining population size of approximately 500,000 plants within the first ten years after founders are transplanted (USFWS, 2012).

4. At least 1,000 seeds representing both the existing Presidio and Daly City populations are stored and maintained in qualified botanical gardens as insurance against extinction in the wild (USFWS, 2012).

5. The Lobos Dunes unit has expanded to Battery Caulfield Road and upper Baker Beach (USFWS, 2012).

Recovery Priority Number: 2C

**Delisting Criteria:**
1. Expanded, restored reserves with natural vegetation and dune dynamics are established in the Presidio Recovery Unit. The area including Baker Beach dunes, Lobos Dunes and nearby conifer groves, Wherry Dunes and Housing sites, and the Battery Caulfield Road site must be restored to a contiguous dune field (approximately 44 hectares [110 acres]) with unobstructed wind fetch to the Golden Gate, locally steep dune slopes, and a natural successional mosaic of active and stabilizing dune blowouts (population at least 500,000 plants; nonnative vegetative cover must not exceed 5 percent during the first 10 years of restoration and must decline over the first 15 years). Dune habitat at the Rob Hill reserve area must increase to 2 hectares (5 acres) and the southwest slope of Rob Hill must be restored to dune scrub (population at least 100,000 plants; nonnative vegetative cover must not exceed 5 percent). At least 3 hectares (7 acres) of the Public Health Services Hospital dune area above the slope must be restored to native dune vegetation (population at least 50,000 plants; nonnative vegetative cover must not exceed 5 percent). Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

2. At least 1.2 hectares (3 acres) of Daly City Reserve in the Southern Recovery Unit are cleared of nonnative vegetation and intensively managed (population at least 50,000 plants; no increases in nonnative vegetation (USFWS, 2003).

3. Dune restoration and vegetation management should be done on 30 hectares (75 acres) at Fort Funston Reserve in the Southern Recovery Unit sufficient to establish ecosystem function and support a self-sustaining population of San Francisco lessingia. Site-specific studies of recreational use management compatible with maintenance of a dune scrub community must be completed to further define the restoration and management strategies. Buffers of landscape vegetation around all historic structures and buffer management needs will also need to be identified. A population should be reintroduced from the Daly City seed source (population at least 10,000 plants after 5 years; must reach 500,000 plants after 10 years; new colonies must spontaneously establish within 10 years). Nonnative woody vegetative cover must be below 1 percent; iceplant and European beachgrass cover must decline and be below 10 percent after 10 years. Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

4. Populations must be introduced in the Satellite Recovery Unit (should reach 100,000 plants within 10 years, with minimum size of 5,000 plants). This criterion is preliminary subject to additional information. The locations of dune areas suitable for management within this Recovery Unit are scattered around the western half of San Francisco County. The specific size, number, and configuration of reserves needs to be determined on the basis of more detailed site-specific information (USFWS, 2003).

**Recovery Actions:**

- Protect and restore a series of ecological urban wildland reserves (USFWS, 2003).
- Promote population increases of target species within urban wildland reserves and reintroduce target species to restored habitat (USFWS, 2003).
- Long-term removal (local eradication) or suppression of invasive, nonnative vegetation within and around all reserves and subsequent reestablishment of native communities compatible with endangered species within the ecological reserves (USFWS, 2003).
- Identify a lead organization to monitor and manage the Hillside Park occurrence in Daly City. Encourage a volunteer weeding program at this site with coordination and assistance from City of Daly City, San Bruno Mountain Watch, California Native Plant Society, other environmental groups, landowners, and school groups (USFWS, 2012).
- Continue control of invasive plants, particularly annual grasses and forbs, through ongoing stewardship on the Presidio (USFWS, 2012).
- Expand Lessingia germanorum habitat in the Presidio through implementation of the Presidio Vegetation Management Plan objectives, particularly in the Wherry Reserve area (USFWS, 2012).
- Collect seed from all populations for accession at approved seed banking facilities and for outplanting within the Presidio and at other suitable habitat within the historic range of the species (USFWS, 2012).
- Formulate adaptive management strategies for native dune scrub succession that would mimic natural disturbance where such natural processes have been reduced or eliminated entirely (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Develop site-specific management plans for occupied areas in the Presidio and Fort Funston populations (Service 2003, p. 207), and implement habitat management and population monitoring in accordance with the plans. Establish monitoring and management goals commensurate with available funding. 2. Include removal of non-native shading trees at Battery Caulfield in management plan for that site. Seek funding to remove trees. 3. Collect seeds at all occupied locations and for storage at facilities approved by the Center for Plant Conservation. 4. Conduct research into how long San Francisco lessingia seeds can remain viable in the soil. 5. Survey the San Bruno population (USFWS, 2024).

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# SPECIES ACCOUNT: *Liatris ohlingerae* (Scrub blazingstar)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/28/1989; Southeast Region (R4)

**Physical Description**

The scrub blazing star (Liatris ohlingerae), a member of the aster family, is a long-lived perennial herb having a thickened, cylindric root. Its stems are erect, usually unbranched, and it can grow up to 1 m tall. Its leaves are fleshy and narrow (1 to 2.5 mm), and generally 3 to 8 cm long (Wunderlin et al. 1980). Flower heads are well separated on the stem with individual disc flowers up to 1 cm broad; the inflorescences are up to 3 cm across. The corollas are bright purplish-pink in color. The broad flower heads and narrow leaves distinguish L. ohlingerae from the eight other Liatris species in central Florida. (USFWS, 1999)

**Taxonomy**

Blake (1923) placed L. ohlingerae in the blazing star genus, naming it Lacinaria ohlingerae. Small (1924) created a new genus for this plant, which became Ammopursus ohlingeri. Robinson (1934) reinstated the scrub blazing star in the large genus of the blazing stars as Liatris ohlingerae. Gaiser's (1946) treatment of Liatris, and Cronquist's (1980) floristic treatment of the aster family in the Southeast retains this plant in the genus Liatris, although Lakela (1964) argued in favor of reinstating Ammopursus as a genus containing only one species. (USFWS, 1999)

**Historical Range**

Highlands and Polk Counties, Florida (USFWS, 1999)

**Current Range**

Southern Lake Wales Ridge of southern Polk and Highlands Counties, Florida (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: pollinators

**Breeding Season**

Adult: Peak flowering of scrub blazing star is from June through August.

**Other Reproductive Information**

Adult: The growth of new basal leaves begins in March and the elongation of stems begins in April. Flowering and fruiting occurs from summer through fall. Flowering begins in May and June, but the peak occurs in August with a rapid decline toward the middle of September. The seeds start to disperse in August and peak in October. Each plant produces approximately eight filled (presumably viable) seeds a year. The plant's above ground parts die back in October to November or by the first freeze. Liatis ohlingerae can remain in a dormant state through at least one growing season. The seedling growth rate for L. ohlingerae is slow compared to most other scrub endemics. Many others grow to reproductive maturity in only one season, while the juvenile stage for L. ohlingerae was found to be at least 2 years. Interestingly, cultivated L. ohlingerae mature to flowering in 8 months. Limited water and nutrients are believed to be responsible for the difference between wild populations and cultivated plants. (USFWS, 1999)

**Reproduction Narrative**

Adult: Liatris ohlingerae requires cross-pollination to reproduce. Butterflies, especially skippers (Hesperiidae), are thought to be the primary pollinators, although other insects may also contribute to pollination (FWS 1996). Flowering and fruiting in this species all more abundant in shaded microhabitats. Individuals in open and edge habitats only produce one-quarter as many mature flower heads (Herndon 1996). The seeds of this species are short-distance wind dispersers, with bristles and hairs that assist in "planting" the seeds correctly. Low germination on leaf litter-covered soil suggests that many seeds in shade (the favored microhabitat) may get trapped in the leaf litter and fail to sprout or die shortly after sprouting (Herndon 1996). (USFWS, 1999)

**Habitat Type**

Adult: Rosemary bald habitats and adjoining scrubby flatwoods

**Environmental Specificity**

Adult: Narrow (USFWS, 2019)

**Habitat Narrative**

Adult: The species is found in rosemary scrub and also along the ecotone between rosemary scrub and scrubby flatwoods. It can also be found scattered in surrounding scrub. Scrub blazing star has important microhabitat requirements, particularly its preference for shade. Unlike most other scrub endemics, scrub blazing star appears to thrive in lightly shaded areas and does not specialize in open microsites (Herndon 1999, Weekley et al. 2008b). Both rosemary scrub and scrubby flatwoods are pyrogenic (fire-maintained) communities. Historical FRIs in rosemary scrub ranged from 20 to 100 years, while scrubby flatwoods have a 5 to 20 year average FRI. (USFWS, 2019)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: No information available.

***Population Information and Trends***

**Population Trends:**

Only 6 populations are considered stable, 7 are estimated to be declining, and 32 have an unknown status mostly due to lack of recent surveys (USFWS, 2021)

**Number of Populations:**

~45 extant (USFWS, 2021)

**Population Narrative:**

Scrub blazing star is extant on the Lake Wales Ridge (roughly 90 to 100 occurrences) and Winter Haven Ridge (one occurrence) in Highlands and Polk Counties. Its range extends from Lake Blue in Polk County south along the Lake Wales Ridge to ABS at the south end of the Ridge in Highlands County (FNAI 2009a). The last FNAI Element Tracking Summary (FNAI 2015) reported 70 extant occurrences, 45 of which were on managed areas. This was a significant decrease (approximately 23 percent) from the last 5-year status review (Service 2010a), which reported 91 extant occurrences. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of L. ohlingerae, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the rosemary bald of the xeric oak scrub community to support L. ohlingerae (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**

- Determine current distribution of L. ohlingerae. This species is difficult to survey. It is easily overlooked when not in bloom and does not grow in the typical open gaps of scrub. A thorough survey is needed to determine the distribution for this species. Survey efforts should be focused from August through October. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Conduct research on life history characteristics. Though recent work has greatly increased the base of knowledge for this species, more work on its basic biology and ecology is necessary for effective recovery. (USFWS, 1999)
- Monitor existing populations of L. ohlingerae. (USFWS, 1999)
- Provide public information about L. ohlingerae. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific location information. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of L. ohlingerae and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support scrub blazing star. • Work with private landowners to acquire or conserve extant populations and restore scrub habitat on these sites. • Ensure representation of scrub blazing star at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. Monitoring/Research Activities • Determine the condition of populations on private land whose status is currently unknown. • Continue demographic monitoring at ABS and LWRSF and expand to additional populations throughout the range to evaluate population trends. • Conduct monitoring to document presence on protected lands at least every five years (Menges et al. 2019). • Conduct presence/absence surveys in areas of suitable habitat within and north of the current range to discover new populations, expand extent of known populations, or to verify the species is not likely present. • Determine the factors responsible for low seedling recruitment. Specifically, examine potential impacts from changes in the timing and amount of precipitation expected with climate change. • Evaluate the overall threat posed by herbivory across the range and at various life stages. (USFWS, 2021)

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# SPECIES ACCOUNT: *Lilaeopsis schaffneriana var. recurva* (Huachuca water-umbel)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 1997, Southwest Region (R2)

**Physical Description**

Lilaeopsis schaffneriana ssp. recurva is a semi-aquatic to fully aquatic herbaceous perennial in the carrot family (Apiaceae). The root system is comprised of both long horizontal rhizomes and connected shorter vertical rhizomes. Hollow linear leaves that taper to a point are produced singly or in clusters at the top of short rhizomes. The leaves vary greatly in length from 2.5 to 33 centimeters (cm) (0.98 to 12.99 inches (in)) depending on their habitat, with shorter leaves typically found in dryer environments and longer when submerged in water. Umbels (umbrella-like flower structures) are born on stalks shorter than the leaves and contain three to ten 1.0 to 2.0 mm (0.04 to 0.08 in) wide perfect flowers with five white to slightly maroon tinted petals and maroon anthers. Fruits are spherical and dry, 1.6 to 2.3 mm (0.6 to 0.09 in) long by 1.2 to 2.0 mm (0.04 to 0.08 in) broad, with five distinct spongy ribs that make the seed buoyant and easily dispersed by water.

**Taxonomy**

Lilaeopsis schaffneriana ssp. recurva is a member of the carrot family (Apiaceae). Within the Apiaceae, Lilaeopsis is in tribe Oenantheae and subfamily Apioideae. In general, researchers consider plants west of the Continental Divide in Sonora to be ssp. recurva and those to the east, ssp. schaffneriana (64 FR 37441, p. 37442). Genetic analysis is warranted to better understand the relationship of occurrences within and between localities in southeastern Arizona, northern Sonora, and northwestern Chihuahua, Mexico (USFWS, 2017).

**Historical Range**

The type specimen of L. schaffneriana ssp. recurva was collected in the Santa Cruz Valley of southern Arizona near Tucson on May 19, 1881, in an area that is now encompassed by the City of Tucson and no longer provides suitable habitat for the species.

**Current Range**

Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, we are aware of 17 locations supporting extant occurrences of L. schaffneriana ssp. recurva, 8 locations where all L. schaffneriana ssp. recurva occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years. Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting L. schaffneriana ssp. recurva occurrences, though most of these locations have not been revisited in recent years (USFWS, 2017).

**Critical Habitat Designated**

Yes; 7/12/1999.

**Legal Description**

On July 12, 1999, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lilaeopsis schaffneriana var. recurva (Huachuca water-umbel) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Arizona(64 FR 37441-37453).

**Critical Habitat Designation**

The critical habitat designation for Lilaeopsis schaffneriana var. recurva includes seven CHUs in Cochise and Santa Cruz counties, Arizona.  Designated habitat includes a total of 83.2 kilometers (km) (51.7 miles (mi)) of streams or rivers (64 FR 37441-37453).

Unit 1. Santa Cruz County, Arizona. From USGS 7.5' quadrangle map Sonoita, Arizona. Gila and Salt Principal Meridian, Arizona: T. 20 S., R. 16 E., beginning at a point on Sonoita Creek in sec. 34 at approx. 31°39'19'' N latitude and 110°41'52'' W longitude proceeding downstream (westerly) to a point in sec. 33 at approx. 31°39'07'' N latitude and 110°42'46'' W longitude covering approx. 2 km (1.25 mi.).

Unit 2. Santa Cruz County, Arizona. From USGS 7.5' quadrangle map Lochiel, Arizona. That portion of the Santa Cruz River beginning in the San Rafael De La Zanja Grant approx. at 31°22'30'' N latitude and 110°35'45'' W longitude downstream (southerly) to Gila and Salt Principal Meridian, Arizona, T. 24 S., R. 17 E., through secs. 11 and 14, to the south boundary of sec. 14 covering approx. 4.4 km (2.7 mi.). Also, a tributary that begins in T. 24 S., R. 17 E., sec. 13 at approx. 31°21'10'' N latitude and 110°34'16'' W longitude downstream (southwesterly) to its confluence with the Santa Cruz River covering approx. 3 km (1.9 mi.).

Unit 3. Cochise County, Arizona. From USGS 7.5' quadrangle map Huachuca Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Scotia Canyon beginning in T. 23 S., R. 19 E., sec. 3 at approx. 31°27'19'' N latitude and 110°23'44'' W longitude downstream (southwesterly) through secs. 10, 9, 16 and to approx. 31°25'22'' N latitude and 110°25'22'' W longitude in sec. 21 covering approx. 5.4 km (3.4 mi.).

Unit 4. Cochise County, Arizona. From USGS 7.5' quadrangle map Huachuca Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Sunnyside Canyon beginning in T. 23 S., R. 19 E., on the east boundary of sec. 10 downstream (southwesterly) to the south boundary of sec. 10 covering approx. 1.1 km (0.7 mi.).

Unit 5. Cochise County, Arizona. From USGS 7.5' quadrangle map Miller Peak, Arizona. That portion of Garden Canyon in the Fort Huachuca Military Reservation beginning at approx. 31°27'13'' N latitude and 110°22'33'' W longitude downstream (northwesterly) to approx. 31°28'45'' N latitude and 110°20'11'' W longitude covering approx. 6.1 km (3.8 mi.).

Unit 6. Cochise County, Arizona. From USGS 7.5' quadrangle map Miller Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Bear Canyon beginning at a point in T. 24 S., R. 19 E., sec. 1 at approx. 31°22'30'' N latitude and 110°21'47'' W longitude upstream through T. 23 S., R. 19 E., sec. 36 to a point in sec. 31 at approx. 31°23'18'' N latitude and 110°21'22'' W longitude covering approx. 1.7 km (1.0 mi.). Also, continuing up an unnamed tributary beginning at a point in T. 23 S., R. 19 E., sec. 31 at approx. 31°23'18'' N latitude and 110°21'22'' W longitude upstream (northerly) to a point in T. 23 S., R. 19 E., sec. 30 at approx. 31°23'44'' N latitude and 110°21'14'' W longitude covering approx. 0.9 km (0.5 mi.). Also, that portion of Lone Mountain

Canyon beginning at its confluence with Bear Creek at a point in T. 23 S., R. 19 E., sec. 36 at approx. 31°22'54'' N latitude and 110°21'43'' W longitude to a point in sec. 36 at approx. 31°23'26'' N latitude and 110°21'58'' W longitude, thence up an unnamed tributary northwesterly into sec. 25 thence northerly to a point at approx. 31°24'13'' N latitude and 110°21'54'' W longitude covering approx. 2.7 km (1.7 mi.). Also that portion of Rattlesnake Canyon beginning at its confluence with Lone Mountain Canyon in T. 23 S., R. 19 E., sec. 36 upstream northeasterly into sec. 25 to a point at approx. 31°22'08'' N latitude and 110°21'31'' W longitude covering approx. 1.5 km (1.0 mi.).

Unit 7. Cochise County, Arizona. From USGS 7.5' quadrangle maps: Hereford, Ariz.; Tombstone SE, Ariz.; Nicksville, Ariz.; Lewis Springs, Ariz.; Fairbank, Ariz.; Land, Ariz. Gila and Salt Principal Meridian, Arizona: That portion of the San Pedro River beginning in the San Rafael Del Valle Grant at a point approx. 200 meters upstream (south) of the Hereford Road bridge at approx. 31°26'16'' N latitude and 110°06'24'' W longitude continuing downstream (northerly) through the San Rafael Del Valle Grant; T. 21 S., R. 22 E.; T. 21 S., R 21 S.; through the San Juan De Las Boquilla y Nogales Grant to a point at approx. 31°48'28'' N latitude and 110°12'32'' W longitude covering approx. 54.2 km (33.7 mi.).

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation.  The PCEs of Lilaeopsis schaffneriana var. recurva critical habitat consists of four components (64 FR 37441-37453):

(1) Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of Lilaeopsis;

(2) A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for Lilaeopsis expansion;

(3) A riparian plant community that is relatively stable over time and in which nonnative species do not exist or are at a density that has little or no adverse effect on resources available for Lilaeopsis growth and reproduction; and

(4) In streams and rivers, refugial sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstem rivers, that allow each population to survive catastrophic floods and recolonize larger areas.

***Life History***

**Food/Nutrient Resources**

**Food Source**

Adult: Substrate nutrients

**Food/Nutrient Narrative**

Adult: Organic, perenially wet (or nearly so) soils comprised of silt or clay (Titus and Titus 2008) provide the nutrients needed for growth.

**Reproductive Strategy**

Adult: Vegetative (clonal), experiments suggest that most if not all Lilaeopsis spp. are self-compatible.

**Dependency on Other Individuals or Species**

Adult: Although the pollinator(s) of this taxon is unknown, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of Lilaeopsis schaffneriana ssp. recurva flowers along the San Pedro River in both 2012 and 2013; he believes this may be an important pollinator for the taxon.

**Breeding Season**

Adult: Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren et al. 1991, p. 15). Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3) and flowering can begin within three months of germination.

**Key Resources Needed for Breeding**

Adult: Hydrologic regime; intermediate level of flooding (not scouring)

**Reproduction Narrative**

Adult: Although Lilaeopsis schaffneriana ssp. recurva is capable of reproducing both sexually, through seed, and asexually, through rhizomes, vegetative reproduction is likely the primary form of reproduction. Never-the-less, natural seed banks are important for the persistence of rare species and observations in the field suggest L. schaffneriana ssp. recurva seed may remain viable for 5 to 10 years, an important survival strategy during times of drought. Another important survival strategy of L. schaffneriana ssp. recurva are its rhizomes, which enable occurrences to rapidly expand or contract in size between years, seasons, or both, in response to local environmental conditions including temperature and water availability. The taxon can re-root if clumps of rhizomes are dispersed via floods to new habitats. Periodic low to moderate flooding provides disturbed open space for re-colonization, reduces competition (FWS 1999), and acts as a dispersal mechanism for seeds and dislodged clumps (Titus and Titus 2008, FWS 1997). Dislodged clumps only survive if they are deposited in sites that provide the necessary habitat (see sheltering) (Titus and Titus 2008). Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren et al. 1991, p. 15). Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3). Although the pollinator(s) of this taxon is unknown, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of Lilaeopsis schaffneriana ssp. recurva flowers along the San Pedro River in both 2012 and 2013; it is believed this may be an important pollinator for the taxon (USFWS, 2017).

**Habitat Type**

Adult: Cienegas (marshes), rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content; generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods. The taxon occurs in both full sun and understory shade of Fremont cottonwood-Goodding willow forests. Found between 610 to 2,170 m (2,001-7,060 ft) elevation in the US, the range of the taxon crosses the Sierra Madrean Region of southeastern Arizona and adjacent portions of Sonora, Mexico (USFWS, 2017).

**Habitat Vegetation or Surface Water Classification**

Adult: (1) Forest & Woodland, (2) Shrubland & Grassland, (3) Semi-desert, (5) Aquatic Vegetation

**Dependencies on Specific Environmental Elements**

Adult: Yes; see key resources needed

**Environmental Specificity**

Adult: High

**Tolerance Ranges/Thresholds**

Adult: Low

**Site Fidelity**

Adult: None

**Habitat Narrative**

Adult: The Huachuca water umbel is found between 610 and 2,170 m (2,001 and 7,060 ft) elevation in the Sky Island Region of southeastern Arizona and as high as 2,240 m (7,349 ft) elevation in adjacent portions of Sonora, Mexico (Titus & Titus 2008 p. 459; Vernadero Group 2011 p. 3; Vernadero Group & Desert Botanical Garden 2012 p. A-16). The taxon is found in deep riparian soils along the margins of flood plains, stream terraces, cienegas, and alluvial fans in 0 to 15 cm of water (USFWS, 2024).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low

**Dispersal**

Adult: Usually through flood waters, but long-distance despersal of seeds or rhizonmes by birds or other vectors might be responsible for geographically distant occurrences.

**Dispersal/Migration Narrative**

Adult: Surface and groundwater development has disrupted aquatic habitat connectivity that once provided opportunities for expansion of the population into new, downstream habitats after flood events. After a flood, Lilaeopsis can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. In rivers and streams, the expansion and contraction of Lilaeopsis populations appears to depend on the presence of ‘‘refugia’’ where the species can escape the effects of scouring floods, a watershed that has an unaltered flow regime, and a healthy riparian community that stabilizes the channel. (USFWS 1999). At present, the known populations are largely isolated from other waterways. Long-distance despersal of seeds or rhizonmes by birds or other vectors might be responsible for geographically distant occurrences.

***Population Information and Trends***

**Population Trends:**

Declining

**Species Trends:**

Stable or declining across range

**Number of Populations:**

30 naturally-occurring locations in the U.S. and 21 in Sonora, Mexico.

**Population Size:**

Individual L. schaffneriana ssp. recurva plants are difficult to identify due to their clonal reproduction and clustered growth habit. In addition, the taxon is difficult to detect due to its diminutive size.

**Additional Population-level Information:**

The clonal nature of the taxon may also reduce genetic diversity, increasing vulnerability to extinction. Occurrences are in many cases isolated which makes the chance of natural recolonization after extirpation less likely (USFWS, 2017).

**Population Narrative:**

Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, we are aware of 17 locations supporting extant occurrences of L. schaffneriana ssp. recurva, 8 locations where all L. schaffneriana ssp. recurva occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years. Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting L. schaffneriana ssp. recurva occurrences, though most of these locations have not been revisited in recent years. The greatest quantities of L. schaffneriana ssp. recurva are found within the San Pedro River, the western Huachuca Mountains and Cienega Creek (USFWS, 2017).

***Threats and Stressors***

**Stressor:** Aquatic habitat degradation
**Exposure:** Not assessed; see narrative
**Response:** Not assessed; see narrative
**Consequence:** Not assessed; see narrative
**Narrative:** Human activities that contribute to aquatic habitat loss and degradation within the historical range of L. schaffneriana ssp. recurva include: groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, agriculture, mining, sand and gravel operations, road building, non-native species introductions, urbanization, wood cutting, wildfires, and recreation (Hendrickson and Minckley 1984, p. 161; Bahre 1991, pp. 177-178; Hereford 1993, p. 2). Flood control projects that permanently alter stream flow characteristics may reduce or eliminate stream sinuosity and associated pool and backwater habitats that are critical to L. schaffneriana ssp. recurva. Ground water pumping may lead to perennial reaches becoming intermittent or ephemeral and to springs drying out, resulting in the loss of L. schaffneriana ssp. recurva occurrences (Warren et al. 1991, p. 7; 60FR 16836, p. 16838; Service 2014b, pp. 148-149). Such activities are widespread in Arizona.

**Stressor:** Wildfire and associated sedimentation and scouring
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire would generally not burn the wetland habitat of L. schaffneriana ssp. recurva due to high humidity; however it has the potential to burn adjacent upland habitats causing indirect effects on L. schaffneriana ssp. recurva and its habitat throughout the range of the taxon (Service 2009a, p. 21). Effects include increased runoff of floodwaters, deposition of debris and sediment originating in the burned area, and potential for scouring of L. schaffneriana ssp. recurva individuals and habitat (Service 2014b, p. 145). Since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970 to 1986 (Westerling et al. 2006, p. 941). The timing, frequency, extent, and destructiveness of wildfires are likely to increase (Westerling et al. 2006, p. 943) and with them changes in vegetation community composition and structure, increased presence of invasive exotic plants, and alterations in the hydrologic and nutrient cycles (Griffis et al. 2000, p. 243; Crawford et al. 2001, p. 265; Hart et al. 2005, p. 167; Smithwick et al. 2005, p. 165; Stephens et al. 2014, p. 42). Post-fire flooding and associated sedimentation can strip out, bury, or stunt growth of L. schaffneriana ssp. recurva patches, or transform habitat from wet or marshy to dry, sandy, or gravelly (Service 2009a, p. 24; Service 2013a, p. 4). At lower elevations, the spread of non-native invasive grasses has been increasing in recent decades and these non-native grasses not only out-compete native grassland species, but they have a completely different fire regime than the native grasses, tending to form dense stands that promote higher intensity fires more frequently (USFWS, 2017).

**Stressor:** invasive, non-native plant competition
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Lilaeopsis schaffneriana ssp. recurva are most abundant in areas with ample sunlight and low competition with other native and non-native species (Titus and Titus 2008c, p. 459). The best available scientific and commercial information indicates that invasive exotic plants have increased their presence within aquatic habitat of southeastern Arizona, and this invasion and expansion of infestations are expected to continue. Because L. schaffneriana ssp. recurva is sensitive to competition from both native and non-native herbaceous plants, the continued increase in such species as S. halepense, C. dactylon, N. officinale, and R. discolor can only lead to a decrease in the presence of L. schaffneriana ssp. recurva throughout the range of the taxon (USFWS, 2017).

**Stressor:** Livestock grazing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Lilaeopsis schaffneriana ssp. recurva are affected by livestock grazing in the following ways: 1) trampling, 2) direct impacts from construction of range improvement projects, 3) changes in stream geomorphology that lead to erosion, sedimentation, and downcutting, 4) watershed degradation and resulting adverse effects to stream hydrology, and 5) consumption (Service 1999, p. 237; Anderson 2006, p. 28). Observations of L. schaffneriana ssp. recurva response to grazing indicate the taxon is capable of experiencing light to moderate grazing with

negligible impact (Simms pers. comm. October 26, 2011; Anderson 2006, pp. 22, 31; Edwards pers. comm. February 21, 2001; Rorabaugh 2013, entire). However, grazing during dry periods when cattle spend a disproportionate amount of their time, if not controlled, in riparian areas, may result in harmful effects to L. schaffneriana ssp. recurva and other riparian obligates (Edwards pers. comm. February 21, 2001; Service 2002a, pp. 76-77; Krueper 1996, p. 287; Malcom and Radke 2008, p. 81; Service 2014a, pp. 3, 6-7). In such instances, severe and widespread trampling may occur; roots and soil structure can be damaged; vegetation species composition and structure can shift; soil can become compacted; stream banks can be degraded; runoff and soil erosion from storm events may increase with higher peak flows; and stream entrenchment may occur; all of which would have harmful effects on L. schaffneriana ssp. recurva habitat and existing occurrences (Service 2002a, p. 138; Krueper 1996, pp. 287-288; Simms pers. comm. October 26, 2011). In instances where natural disturbance is low or infrequent, occasional trampling and grazing by domestic livestock could improve habitat for L. schaffneriana ssp. recurva; poorly managed livestock use, however, can be detrimental to the taxon and its habitat (USFWS, 2017).

**Stressor:** Dought and climate change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Lilaeopsis schaffneriana ssp. recurva evolved in the Southwest and has persisted in many locations throughout its range through historical droughts such as those of the 1950s. However, given the severity and persistence of the present multi-year drought, it is unknown how long L. schaffneriana ssp. recurva will maintain viability in de-watered habitat. It has been suggested that seed from this taxon may persist for 5 to 10 years in such situations (Titus and Titus 2008a, p. 319; Titus and Titus 2008b, p. 398; Titus and Titus 2008c, p. 463). There is a reasonable likelihood that the current drought and rise in temperatures will continue for many more years throughout the range of L. schaffneriana ssp. recurva. It is unknown how long L. schaffneriana ssp. recurva can remain dormant during an extended drought. The projected drought will likely contain periods of high year-to-year precipitation variability characteristic of Southwest climate. Rise in temperature is also likely to continue for many more years. Whether this variability will be enough to preserve occurrences L. schaffneriana ssp. recurva remains unknown.

**Stressor:** Recreation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recreational activities, such as hiking and camping, if poorly managed, can result in soil compaction, streambank destabilization, erosion and sedimentation, increases in the presence of invasive non-native plant species, and trampling of L. schaffneriana ssp. recurva and other riparian plant species, thus reducing habitat quality (USFWS 2017).

### *Recovery*

**Reclassification Criteria:**
A minimum cumulative extent of 2,000 square meters (0.2 ha / 0.5 ac) of naturally occupied habitat exists in the San Pedro Watershed, 20 percent of which occurs in tributary streams,

springs, or cienegas; and a minimum of 2,000 square meters (0.2 ha /0.5 ac) in the Santa Cruz Watershed, 90 percent of which occurs in tributary streams, springs, or cienegas, distributed among the areas of Cienega Creek (35 percent), Sonoita Creek (10 percent), the San Rafael Valley uplands and mainstem (10 percent), and the western Huachuca Mountains (35 percent); and a minimum of 125 square meters (0.01 ha / 0.03 ac) exists in the Rio Yaqui Watershed; this level of occupancy is sustained or improved for a minimum of 10 years over a 15 year period. (USFWS, 2017)

At least 3 separate introduced occurrences with a minimum cumulative extent of 150 square meters (0.015 ha / 0.037 ac) of occupied habitat are placed in each of the three United States watersheds and are stable or increasing over a 10 year period (USFWS, 2017).

Threats to the taxon and its habitat have been managed and reduced, and management is in place for a minimum of 20 years to ensure the persistence of occurrences with minimum cumulative extent (as reflected by the achievement and maintenance of downlisting criteria 1 and 2) in each of the three United States watersheds (USFWS, 2017).

A living collection of as many plugs as resources allows, collected from genetically distinct regions (e.g. Fort Huachuca / SPRNCA north; San Rafael / Las Cienegas / Sonoita; SPRNCA south / San Bernardino), from both the San Pedro and the Santa Cruz watersheds is maintained in at least one botanical garden in southern Arizona for recovery and educational purposes (USFWS, 2017).

Seeds of L. schaffneriana ssp. recurva are collected following Center For Plant Conservation guidelines, which include collecting from no more than 10 percent of the standing seed crop from 50 individual seed bearing plants per population (if the population size permits), and collecting from a variety of microsites and physical characteristics within the stand of plants. These seeds are stored at both the Agricultural Research Service National Center for Genetic Resources Preservation in Fort Collins, Colorado and stored according to protocols at a local facility such as the Desert Botanical Gardens in Phoenix, Arizona, for long-term conservation and recovery purposes (USFWS, 2017).

Recovery Priority Number: 3C

**Delisting Criteria:**
To delist L. schaffneriana ssp. recurva, the criteria for down-listing must be met and the level of occupancy in the downlisting criteria is sustained or increasing for a minimum of 20 years over a 30 year period (USFWS, 2017).

**Recovery Actions:**
- Maintain or enhance groundwater hydrography, as measured by both well observations and stream gages, by reducing water withdrawal and increasing water conservation and recharge (USFWS, 2017).
- Conserve historical, existing, newly discovered, and newly established L. schaffneriana ssp. recurva occurrences and their seedbanks through the protection of occupied habitat, unoccupied corridors, and habitat quality; augment existing and establish new L. schaffneriana ssp. recurva occurrences in appropriate habitat using appropriate genetic stock to increase the redundancy (number of occurrences) and resiliency (size of

occurrences) of the taxon to help ensure the long-term survival of the taxon in southern Arizona; establish plants at botanical gardens and other Service approved facilities for research, recovery, and educational purposes; and maintain seeds for conservation and recovery at seed storage facilities (USFWS, 2017).

- Remove stressors related to invasive plants and poorly managed livestock grazing to historical, existing, newly discovered, and newly established L. schaffneriana ssp. recurva occurrences and their habitats (USFWS, 2017).
- Work toward a standardized monitoring technique and continue monitoring occurrences (USFWS, 2017).
- Conduct research and monitoring that will facilitate better understanding of: a) the distribution and genetics of the taxon in both the United States and Mexico, b) population and metapopulation dynamics and trends, c) life history, d) response to threats, and e) other relationships key to recovery of the species (USFWS, 2017).
- Develop collaborative partnerships with Federal and State land managers, private landowners, museums and botanical gardens, seed storage facilities, and others; provide outreach to the public as needed to accomplish recovery; promote the achievement of conservation and recovery in Mexico, resulting in long-term protection of L. schaffneriana ssp. recurva and its habitat; in coordination with stakeholders, revise this plan as needed as new information comes to light so that the recovery strategy and actions implement recovery in as efficient a manner as possible (USFWS, 2017).
- The principal recovery strategy is to conserve the habitat of L. schaffneriana ssp. recurva by decreasing groundwater pumping, increasing water conservation and recharge, and protecting L. schaffneriana ssp. recurva occurrences and their seed banks (USFWS, 2018).
- Monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors (USFWS, 2018).
- Introduction and Augmentation of occurrences: There has been success in establishing L. schaffneriana ssp. recurva into locations with suitable habitat within the historical range of the taxon (e.g. Audubon Research Ranch, Las Cienegas National Conservation Area, Fort Huachuca, and on the San Pedro Riparian National Conservation Area). Other attempts to establish this taxon have ultimately failed (e.g. Leslie Canyon National Wildlife Refuge and Sonoita Creek). Still other attempts have had mixed results (e.g. San Bernardino National Wildlife Refuge).
- Easements: Since 1990, the Nature Conservancy has held a conservation easement on one private property on Sonoita Creek which supports L. schaffneriana ssp. recurva (Killeen pers. comm. April 29, 2014). Although the easement was created for a purpose other than the protection of L. schaffneriana ssp. recurva, the taxon benefits from this land protection. Several additional conservation easements on the Babacomari River are held by The Nature Conservancy, Fort Huachuca, and the Bureau of Land Management; collectively these easements protect several miles of perennial water in the Babocomari River (Duncan pers. comm. April 29, 2014).
- In 1999, Arizona State Parks purchased 1,440 ha (3,557 ac) of land in the San Rafael Valley including the Santa Cruz River which supports small occurrences of L. schaffneriana ssp. recurva. The land is rested from livestock grazing, protected from development through an easement, and is managed to minimize the impacts of non-native species. In 2013, the Arizona Land Trust protected 3.2 km (2 mi) of Sonoita Creek on the Circle Z Ranch, including perennial stretches.

- In Sonora, Mexico, Rancho El Aribabi is a federally designated private reserve, which recognizes ecological values and also precludes mineral entry. The Ranch, which contains L. schaffneriana ssp. recurva, is managed for its ecological values and ecotourism. Similarly, Rancho los Fresnos, which also supports an occurrence of L. schaffneriana ssp. recurva, is owned and managed for its ecological values by the conservation organization Naturalia. Livestock have been removed from the property and management includes the use of prescribed burning. At Rancho San Bernardino, in Sonora, the Cuenca los Ojos Foundation actively manages lands known to have historically supported and may currently support L. schaffneriana ssp. recurva. Management includes extensive restoration of grasslands and waterways, resulting in the many-fold increase in extent of perennial water in Rio San Bernardino creating habitat for the taxon.
- Conservation and Management Plans: There are three conservation plans currently in place that provide some benefit to L. schaffneriana ssp. recurva. First, the 2008 Malpai Borderlands Habitat Conservation Plan ensures that no cattle grazing occurs within San Bernardino National Wildlife Refuge, thereby protecting L. schaffneriana ssp. recurva from trampling and overgrazing impacts (MBHCPTWG and Lehman 2008, p. 105). Second, the 2009 Leslie Canyon Watershed Safe Harbor Agreement incorporates management actions related to the recovery of the taxon, including its propagation and establishment in existing aquatic habitats, the maintenance of wetland levels, and the exclusion of humans and livestock that may excessively trample the taxon (Service 2009b, p. 7). Lastly, although most L. schaffneriana ssp. recurva occur outside of Pima County, the Draft Pima County Multi-Species Conservation Plan includes monitoring of a) L. schaffneriana ssp. recurva every 2 to 3 years, b) habitat conditions at Bingham Cienega, and c) post restoration efforts (Pima County 2012, pp. 70, 81).
- Fort Huachuca participates in water conservation efforts, effluent reuse or recharge, the purchase of conservation easements, and storm water recharge; all which benefit L. schaffneriana ssp. recurva and its habitat (Service 2014b, p. 21). In addition, Fort Huachuca personnel monitor L. schaffneriana ssp. recurva both on the Fort and on the San Pedro National Conservation Area regularly (Service 2014b, p. 20). There is no livestock grazing allowed on Fort Huachuca, eliminating the threat L. schaffneriana ssp. recurva of overgrazing and measures are taken to ensure recreational trampling does not occur (Service 2014b, p. 21). In addition, transplanting of plugs has occurred in the past and may continue in the future (Service 2014b, p. 21).
- Conservation Areas: The Bureau of Land Management manages the Las Cienegas National Conservation Area which encompasses much of the upper Cienega Creek watershed, an area supporting multiple patches of L. schaffneriana ssp. recurva. The area was set aside to conserve, protect, and enhance this resource and is managed under a comprehensive management plan which includes assurance that riparian and wetland sites are properly functioning (Bureau of Land Management 2003, pp. 7-9). The Bureau of Land Management also conducts periodic monitoring of L. schaffneriana ssp. recurva along upper Cienega Creek and has plans for introducing plugs at up to 11 locations over a 10 year period (Service 2008, p. 3). In addition, to protect these sensitive riparian and wetland habitats, the Bureau of Land Management designated this area as the Empire-Cienega Area of Critical Environmental Concern. The goal of the designation is to protect and enhance watershed, grassland, and threatened/endangered wildlife resources, emphasizing total ecosystem management (Bureau of Land Management 2003, p. A6-1).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The principal recovery strategy for the Huachuca water umbel is to conserve the habitat by decreasing groundwater pumping, increasing water conservation and recharge, and protecting occurrences and their seedbanks. Providing conservation and restoration of the taxon and its habitat will allow stable, self-sustaining occurrences to persist with some level of connectivity and opportunity for expansion and dispersal. Additional actions needed include monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors. Several recovery actions listed in the Recovery Plan are already under way, including water use reduction and effluent recharge. Also, some introductions have been made with varying success and more introductions are anticipated (USFWS, 2024).

**References**

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# SPECIES ACCOUNT: *Limnanthes floccosa ssp. californica* (Butte County meadowfoam)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 06/08/1992; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

A densely pubescent, winter annual herb. Stems from 3-25 cm in length, generally prostrate with tips curved upward. Flowers are white with dark yellow veins at the base of each of 5 petals (Fish and Wildlife Service 1992) (NatureServe, 2015).

**Taxonomy**

Before 1973, Butte County meadowfoam was not differentiated from the more widespread woolly meadowfoam (Limnanthes floccosa ssp. floccosa). An alternative common name, Shippee meadowfoam, is derived from the type locality (California Department of Fish and Game 1987a, Ornduff 1993c). Limnanthes floccosa ssp. californica is a member of the meadowfoam or false mermaid family (Limnanthaceae), which is a small family comprising only 2 genera and 10 species (Ornduff 1993c) (USFWS, 2005).

**Historical Range**

Endemic to California, only known from Butte County (Skinner 1997) (NatureServe, 2015). Known historically and currently to occur only in Butte County within the Northeast Sacramento Valley Vernal Pool Region (USFWS, 2008).

**Current Range**

At least eight new occurrences of Limnanthes floccosa ssp. californica have been discovered since 1988 (USFWS, 2005). The range of Butte County meadowfoam lies entirely within Butte County, California. Butte County meadowfoam is found primarily on the margins of vernal swales and to a lesser extent on the margins of vernal pools located on alluvial terraces in annual grasslands and mima mound topography. Mima mounds are soil mounds of unknown origin that are a few feet in height. The species is restricted to a narrow 28-mile strip along the eastern flank of the Sacramento Valley from northwestern to central Butte County and occurrences are found at 120 to 1,200 feet in elevation (USFWS, 2023).

**Critical Habitat Designated**

Yes; 2/10/2006.

**Legal Description**

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Limnanthes floccosa ssp. californica (Butte County meadowfoam) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (70 FR 46924-46999).

**Critical Habitat Designation**

The critical habitat designation for Limnanthes floccosa ssp. californica includes four CHUs in Tehama and Butte Counties, California. This species critical habitat encompasses approximately

16,363 acres (71 FR 7118-7316).

Unit 1: Tehama and Butte Counties. (i) Unit 1A: Tehama and Butte Counties, California. From USGS 1:24,000 scale quadrangles Richardson Springs NW, Campbell Mound, Richardson Springs. (ii) Unit 1B: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs.

Unit 2: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs.

Unit 3: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs, Paradise West, Chico.

Unit 4: Butte County, California. From USGS 1:24,000 scale quadrangles Oroville, Shippee.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Limnanthes floccosa ssp. californica critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described in PCE (ii), providing for dispersal and promoting hydroperiods of adequate length in the pools.

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

**Special Management Considerations or Protections**

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/ or primary constituent elements in adjacent critical habitat.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination, self-pollination (USFWS, 2008)

**Lifespan**

Adult: One year (USFWS, 2008)

**Breeding Season**

Adult: February - April (USFWS, 2008)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, based on closely related species (USFWS, 2008)

**Reproduction Narrative**

Adult: This is an annual plant. Limnanthes floccosa ssp. californica typically begins flowering in February, reaches peak flowering in March, and may continue into April if conditions are suitable. Nutlets are produced in March and April, and the plants die back by early May (Jokerst 1989, Dole and Sun 1992). Limnanthes floccosa ssp. californica has floral adaptations that allow for cross-pollination by insects, but self-pollination mechanisms take over to ensure seed set if insect pollination is unsuccessful. The particular pollinators of L. floccosa ssp. californica have not been identified; however, other meadowfoam species are pollinated by the native burrowing bees Andrena limnanthis and Panurginus occidentalis (Thorp and Leong 1998) and by honeybees (Kesseli and Jain 1984), beetles, flies, true bugs (order Hemiptera), butterflies, and moths (Mason 1952, Thorp and Leong 1998) (USFWS, 2008).

**Habitat Type**

Adult: Wetland (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Valley and foothill grasslands, ephemeral drainages, vernal pool depressions (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Mima mound topography (USFWS, 2008)

**Geographic or Habitat Restraints or Barriers**

Adult: 165 - 1,167 ft. elevation (USFWS, 2008)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from USFWS, 2008)

**Habitat Narrative**

Adult: Inhabits valley and foothill grasslands (mesic soils) (Skinner 1997). Associates are Limnanthes alba ssp. alba, L. douglasii var. rosea, and L. floccosa ssp. floccosa. Grows in three types of seasonal wetlands: ephemeral drainages, vernal pool depressions in ephemeral drainages, and occasionally around the edges of isolated vernal pools (Fish and Wildlife Service 1992) (NatureServe, 2015). This species occurs on alluvial terraces in annual grasslands with mima mound topography. The occurrences are found at 165 to 1,167 feet in elevation (McNeill and Brown 1979, CNDDB 2007). Limnanthes floccosa ssp. californica occurs in different soils on Tuscan-Igo-Anita Complex Fan terraces of 0-3 percent slope, 0-50 percent rock cobble with an underlying clay durapan. According to the 2006 Butte Area Soil Survey, L. floccosa ssp. californica is found on 32 different "Musym" classes of soil, but always with an underlying durapan, rock cobble and common hydrological factors (J. Marr, CDFG, in litt. January 2007, Natural Resource Conservation Service 2006). Limnanthes floccosa ssp. californica has also been found occasionally in disturbed areas, such as drainage ditches, firebreaks, and graded sites (McNeill and Brown 1979, Jokerst 1989, Kelley and Associates Environmental Sciences 1992b, BioSystems Analysis, Inc. 1993, Kelley and Associates Environmental Sciences 1993a) (USFWS, 2008).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2008)

**Dispersal/Migration Narrative**

Adult: Nutlets of L. floccosa ssp. californica are apparently dispersed by water and can remain afloat for up to 3 days (Hauptli et al. 1978). Most meadowfoam nutlets are dispersed only short distances. Birds and livestock are potential sources of long distance seed dispersal, but specific instances of such dispersal have not been documented (Jain 1978) (USFWS, 2008).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2008)

**Number of Populations:**

20 (USFWS, 2023)

**Population Narrative:**

In 1989, less than 200,000 plants likely existed in the censused populations (Fish and Wildlife Service 1992) (NatureServe, 2015). There are 20 total extant natural occurrences. Quantitative information on the numbers of plants and area occupied by Limnanthes floccosa ssp. californica has not been collected in a consistent and systematic manner at all occurrences since the time of listing; therefore, definitive range-wide abundance and population trend information is not yet available (USFWS, 2008). At the time of listing in 1992, the species was known from 18 extant populations and 3 extirpated populations within a narrow 25-mile strip along the eastern flank of the Sacramento Valley from central Butte County to the northern portion of the city of Chico (Service 1992, p. 24193). The 2005 Recovery Plan and the 2008 status review reported 21 natural occurrences (20 extant and 1 extirpated prior to listing) and 1 introduced occurrence (Service 2005, p. II-34; Service 2008, p. 2). Sixteen of these occurrences were reported in the Diversity Database in 2007 when the occurrence records were reviewed for the 2008 status review (Service 2008, p. 1). Seven of the natural occurrences were discovered after the 1992 listing (North Table Mountain, Upper Rock Creek, and the five localities on Dove Ridge Conservation Bank that were recorded as one occurrence in the Diversity Database) (Service 2008, p. 2–7), but the range of the species remained largely unchanged. The 2005 Recovery Plan also reported that many of the occurrences revisited since listing had been reduced in extent while the boundaries of other occurrences had expanded due to identification of additional occupied habitat (Service 2005, p. II-34). The introduced experimental population on the Tuscan Preserve in northwestern Butte County was established just outside of the historical range of the taxon using seed from the Doe Mill occurrence (occurrence number 20) and thus marginally increased the range of the species (Service 2005, p. II-36). The Shippee (occurrence number 6) and the North of Skyway/Bruce Road (occurrence number 20) occurrences, which were presumed extirpated at listing (Service 1997, p. 24193), were considered extant at the time of the 2008 status review as the species had been rediscovered at both locations following listing (Service 2008, pp. 6, 8). The current distribution of Butte County meadowfoam is similar to that described in the 2005 Recovery Plan (Service 2005, pp. II-34–36) and 2008 status review (Service 2008, pp. 5–7). The Diversity Database currently reports a total of 20 occurrences including 19 natural occurrences and the introduced occurrence at the Tuscan Preserve (Table 1; Diversity Database 2023, entire). All occurrences of the species are currently presumed extant. The Diesel occurrence (occurrence 39), which was thought to be extirpated prior to listing, is now presumed extant as 16 individuals were observed at the site in 2010 (Diversity Database 2023, entire). Seven occurrences (occurrence numbers 44, 45, 46, 47, 48, 50, and 51) have been added to the Diversity Database since the 2008 status review. Two of these occurrences (occurrence numbers 50 and 51) were discovered after 2008, while the other five occurrences were known prior to 2008 but were not added to the Diversity Database until recently (Diversity Database 2023). Occurrence number 50 is located in proximity to the North Table Mountain Ecological Reserve and occurrence number 42, and the occurrence expands the eastern extent of the species' range by 0.3 miles (Diversity Database 2023). Occurrence number 51 is located within the previously known range of the species in proximity to occurrence number 20. Additionally, three occurrence records (occurrence numbers 34, 41, and 43) have been combined in the Diversity Database with other previously known occurrences. Furthermore, an additional occurrence south of Chico Regional Airport was identified by Sloop et al. (2011), but this occurrence has not yet been added to the Diversity Database (Sloop et al. 2011, p. 315; Diversity Database 2023, entire). Overall, the distribution of Butte County Meadowfoam remains largely unchanged since the 2005 Recovery Plan and the 2008 status review (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** 11 occurrences are located on privately owned land and are unprotected. Habitat loss or degradation from urbanization continues to be the greatest threat to all occurrences of the subspecies, even to those that are protected from development. Habitat degradation results from changes in the amount of surface and subsurface water hydrology, introduction of invasive plants, and in areas adjacent to agricultural or residential uses, introduction of pesticides and herbicides. In addition to the threats from development projects that have already been proposed, rapid population growth is predicted for all of Butte County and its urban areas. The City of Chico predicts the construction of approximately 20,000 new housing units and a 61 percent increase in population by 2030 (Butte County Association of Governments 2006). The population of Butte County is expected to increase by 48 percent by 2030 (Butte County Association of Governments 2006). The need for additional housing and associated development will likely threaten the remaining unprotected occurrences of Limnanthes floccosa ssp. californica which are mostly located in or near existing urban areas or roads (USFWS, 2008).

**Stressor:** Nonnative plants (USFWS, 2008)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** he Draft Land Management Plan for the Doe Mill Preserve (Center for Natural Lands Management 1996) noted that the occurrence of Limnanthes floccosa ssp. californica was "healthy" in 1991 but was reduced in numbers in 1996 and stressed from competition with the nonnative grass, Taeniatherum caput-medusae (medusa-head). Glyceria declinata (waxy manna grass) is a nonnative, perennial grass which may become a threat to Limnanthes floccosa ssp. californica. Glyceria declinata forms dense stands and is able to invade vernal pool habitat and displace native plants (The Nature Conservancy 2006) (USFWS, 2008).

**Stressor:** Drought and climate change (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Maintenance of the natural hydrology of these wetlands is necessary for the survival and recovery of this subspecies. Drought or flood conditions will place additional strains on the vernal pool ecosystems supporting L. floccosa ssp. californica occurrences. Climate is predicted to change in California during the 21st century (Lenihan et al. 2006, Cayan et al. 2005, Field et al. 1999). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Cayan et al. 2005, Field et al. 1999). Although the specific effects of climate change on L. floccosa ssp. californica are not yet known, the predicted shift in precipitation of increased winter runoff and reduced spring and summer rainfall have the potential to adversely affect this subspecies (USFWS, 2008).

**Stressor:** Off-road vehicles (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts from off-road vehicles continue to threaten to the subspecies. In 2006, a vehicle driving off-road in Bidwell Ranch became stuck in the mud near an area supporting L. floccosa ssp. californica (B. Vlamis, pers. comm., 2007). Vehicles can crush the plants and seeds, and compact the soil, thus making germination more difficult, and alter the hydrology of the habitat. Portions of many L. floccosa ssp. californica occurrences are located adjacent to roads and are unfenced thereby exposing them to potential damage from off-road driving (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
See delisting criteria.

Recovery Priority Number: 3C

**Delisting Criteria:**
1. Suitable vernal pool habitat within each prioritized core area for the species is protected (USFWS, 2008).

2. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there (USFWS, 2008).

3. Reintroductions must be carried out and meet success criteria established in the recovery plan (USFWS, 2008).

4. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the recovery plan (USFWS, 2008).

5. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

6. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected (USFWS, 2008).

7. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of criterion 1 - 5 (USFWS, 2008).

8. Monitoring indicates that ecosystem function has been maintained in the areas protected under criterion 1 - 4 for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

9. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2008).

10. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

11. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2008).

12. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both

specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions (USFWS, 2008).

13. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in criterion 1 - 5 (USFWS, 2008).

14. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2008).

15. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts (USFWS, 2008).

16. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts (USFWS, 2008).

17. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria (USFWS, 2008).

**Recovery Actions:**

- Establish a range-wide recovery implementation team (USFWS, 2005).
- Establish working groups and develop participation plans for each vernal pool region (USFWS, 2005).
- Develop and implement adaptive management plans based on monitoring data and best available science (USFWS, 2005).
- Assist local governments in developing habitat conservation plans and developing land use protection measures (USFWS, 2005).
- Assist private landowners in developing landowner agreements (USFWS, 2005).
- Acquire habitat, where necessary (USFWS, 2005).
- Track losses and protection of suitable habitat and occurrences within core areas (USFWS, 2005).
- Ensure mechanisms are in place to provide for the perpetual management and monitoring of core areas, vernal pool regions, or for each management unit within a vernal pool region, as appropriate (USFWS, 2005).
- Permanently protect remaining occurrences through conservation easements, fee title, or other protective methods. Implement existing approved management plans for Limnanthes floccosa ssp. californica. Develop and implement management plans for all occurrences for which management plans have not yet been developed (USFWS, 2008).
- Conduct a status survey of all recorded locations of Limnanthes floccosa ssp. californica to verify the identity of the plants and determine the status, area occupied, micro-site and hydrology analysis, pollinators, and threats of plants present. Many of the occurrences in CNDDB have not been thoroughly surveyed for over 15 years. The one presumed extirpated

site should also be revisited and surveyed (USFWS, 2008).
- Conduct surveys on potential Limnanthes floccosa ssp. californica habitat in Butte County for additional occurrences, including the area northeast of Highway 99 between the City of Chico and the intersection of Highways 70 and 149 (USFWS, 2008).
- Conduct studies to determine the effects of grazing and burning on Limnanthes floccosa ssp. californica and appropriate management at each L. floccosa ssp. californica occurrence based on individual conditions of each location such as soil type and grass species present (USFWS, 2008).
- Conduct a study to determine the effects of nonnative, invasive plants on Limnanthes floccosa ssp. californica and appropriate management at L. floccosa ssp. californica occurrences (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of Butte County meadowfoam. These recommendations have been previously discussed in the 2008 status review (Service 2008, p. 21) and remain valid. 1. Permanently protect remaining occurrences through conservation easements, fee title, or other protective methods. Implement existing approved management plans for Butte County meadowfoam. Develop and implement management plans for all occurrences for which management plans have not yet developed. 2. Conduct a status survey of all recorded locations of Butte County meadowfoam to verify the identity of the plants and determine the status, area occupied, micro-site and hydrology analysis, pollinators, and threats of plants present. Many of the occurrences in the Diversity Database have not been thoroughly surveyed in recent years. 3. Conduct surveys on potential Butte County meadowfoam habitat in Butte County for additional occurrences, including the area northeast of Highway 99 between the City of Chico and the intersection of Highways 70 and 149. 4. Conduct studies to determine the effects of grazing and burning on Butte County meadowfoam and appropriate management at each Butte County meadowfoam occurrence based on individual conditions of each location such as soil type and grass species present. 5. Conduct studies to determine the effectiveness and survival rates of transplanted Butte County meadowfoam. 6. Conduct studies to learn more about seed bank dynamics and length of time that seeds can survive in the soil before germination for Butte County meadowfoam. 7. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the Butte County meadowfoam and develop stepdown success parameters, if appropriate, that reflect the species' life history and narrow range (USFWS, 2023).

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# SPECIES ACCOUNT: *Limnanthes floccosa ssp. grandiflora* (Large-flowered woolly Meadowfoam)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/9/2002; Pacific Region (R1)

**Physical Description**

an upright annual herb with simple stems that occasionally branch near the base. The plants reach 5 to 10 centimeters (2 to 4 inches) high, are mostly glabrous throughout, and have pinnate leaves which are divided into five to nine divisions. The plant's petals are 7.5 to 8 millimeters (0.30 to 0.31 inches) long and equal the sepal length (Figure II-10). The petals are glabrous with the exception of two rows of inside hairs. Each flower produces three to five nutlets. The flowers are white in color with an occasional slight yellow tinge at the base of the petals. (USFWS, 2010)

**Taxonomy**

Limnanthes pumila ssp. pumila, a member of the false mermaid family (Limnanthaceae), was first collected from the top of Table Rock, Jackson County, Oregon, and then described by Howell in 1897 as Limnanthes pumila. M.E. Peck revised the name to Limnanthes bellingeriana in 1937 (Abrams 1951), but C. T. Mason reassigned the name to Limnanthes pumila (Mason 1952). Arroyo (1973) treated the taxon as a subspecies within Limnanthes floccosa, but it is currently assigned to Limnanthes pumila ssp. pumila based on hybridization trials and molecular data (Chambers and Meyers 2011) (USFWS, 2010). In recognition of recent taxonomic changes, on June 23, 2015, we published a technical correction in the Federal Register officially changing the name of the species from Limnanthesfioccosa ssp. grandiflora to Limnanthes pumila ssp. grandijiora (80 FR 35860, p. 35863) (USFWS, 2019).

**Historical Range**

Endemic to the Middle Rogue River of Jackson County, Oregon. (USFWS, 2010)

**Current Range**

Endemic to the Middle Rogue River of Jackson County, Oregon. (USFWS, 2019)

**Critical Habitat Designated**

Yes; 8/20/2010.

**Legal Description**

On July 21, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective August 20, 2010) for Limnanthes floccosa ssp. grandiflora (Large-flowered woolly Meadowfoam) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in Oregon (75 FR 42490-42570).

**Critical Habitat Designation**

The critical habitat designation for Limnanthes floccosa ssp. grandiflora includes eight CHUs in Jackson County, Oregon. This species critical habitat encompasses approximately 5,840 acres (ac) (2,363 hectares (ha)). All critical habitat units in Jackson County are located within the Middle

Rogue River Basin or “Agate Desert.” Brief descriptions are presented below. Detailed coordinates of and maps depicting the CH units are available in the Final Rule (USFWS, 2010).

Unit RV1 for Limnanthes floccosa ssp. grandiflora: Shady Cove, Jackson County, Oregon. (i) Unit RV1 consists of approximately 8 ha (20 ha) of intact vernal pool– mounded prairie habitat. The unit is located 460 m (1,500 ft) west of Highway 62 and parallels a 430-m (1,411-ft) stretch of the highway. The unit is 0.8 km (0.5 mi) south of Shady Cove, 1.3 km (0.8 mi) northeast of Takelma Park, and 122 m (400 ft) east of the Rogue River.

Unit RV2 for Limnanthes floccosa ssp. grandiflora: Hammel Road, Jackson County, Oregon. (i) Unit RV2 is composed of four subunits and comprises approximately 69 ha (169 ac) of vernal pool–mounded prairie. The unit is located 1.2 km (0.75 mi) northeast of the confluence of Reese Creek and the Rogue River, 1.3 km (0.8 mi) west of Highway 62, and 430 m (1,400 ft) east of the Rogue River.

Unit RV3 for Limnanthes floccosa ssp. grandiflora: North Eagle Point, Jackson County, Oregon. (i) Unit RV3 is composed of four subunits and totals 490 ha (1,210 ac) of intact vernal pool habitat. The unit is located southwest of Mosser Mountain and northeast of Long Mountain. The four subunits loosely follow a 6.9-km (4.3-mi) stretch of Hog Creek beginning at its origin. Originating 3.8 km (2.4 mi) east of Highway 62 in subunit RV3D, Hog Creek runs through RV3C, crosses Highway 62, flows between RV3B (located 100 m (328 ft) west of Highway 62) and RV3A (located 600 m (1,970 ft) west of Highway 62), before emptying into the Rogue River after 2.4 km (1.5 mi). Subunit RV3A is located 560 m (1,837 ft) southeast of the confluence of Reese Creek and the Rogue River. Subunit RV3B is located 100 m (328 ft) west of Highway 62 at the intersection of Ball Road and extends along an 835- m (2,740-ft) stretch of Hog Creek. Subunit RV3C is located 2 km (1.2 mi) north of Eagle Point (see Index map) and extends 2.6 km (1.6 mi) south of the junction of Ball Road and Reese Creek Road. Subunit RV3D is located 3.2 km (2 mi) east of Long Mountain and is 2.4 km (1.5 mi) southeast of the junction of Highway 62 and Ball Road. It extends along a 1.8-km (1.1-mi) stretch of Hog Creek.

Unit RV4 for Limnanthes floccosa ssp. grandiflora: Rogue Plains, Jackson County, Oregon. (i) Unit RV4 consists of 243 ha (600 ac) of partially intact vernal pool– mounded prairie habitat. The unit is located 122 m (400 ft) southeast of the junction of Highway 234 and Modoc Road. It extends 2 km (1.2 mi) south along Modoc Road from the intersection, is located 1.4 km (0.87 mi) southwest of Dodge Bridge, and is 1.0 km (0.6 mi) northwest of Rattlesnake Rapids on the Rogue River.

Unit RV5 for Limnanthes floccosa ssp. grandiflora: Table Rock Terrace, Jackson County, Oregon. (i) Unit RV5 includes 49 ha (122 ac) of intact vernal pool–mounded prairie habitat. The unit is located on privately owned land 670 m (2,200 ft) north of the junction of Modoc and Antioc Roads, is 1.4 km (0.9 mi) east of Upper Table Rock, and is 650 m (2,300 ft) west of the Rogue River. This unit follows along an 800-m (2,600-ft) stretch of Modoc Road to the east of the unit and along a 700- m (2,300-ft) stretch of Antioc Road to the west of the unit.

Unit RV6 for Limnanthes floccosa ssp. grandiflora: White City, Jackson County, Oregon. (i) Unit RV6 for Limnanthes floccosa ssp. grandiflora consists of eight subunits totaling 740 ha (1,829 ac) in size and includes intact vernal pool– mounded prairie and swale habitats. The unit is located around White City, is 1.6 km (1.0 mi) southwest of Eagle Point, and is 440 m (1,444 ft) southeast of the confluence of the Rogue River and Little Butte Creek. Subunit RV6A is located north of

Whetstone Creek and is 500 m (1,200 ft) west of the junction of Highway 62 and Antelope Road. Subunits RV6B, RV6C, RV6D, and RV6E are located north of Avenue G in White City, south of Little Butte Creek, and 670 m (2,200 ft) southwest of Antelope Creek. Subunits RV6F and RV6G are located approximately 500 feet west of Dry Creek and are east of Highway 62 in White City. Subunit RV6H is located north of Whetstone Creek and south of Antelope Road. Subunit RV6H roughly encircles the Hoover Ponds, east of Highway 62, and is 850 m (2,790 ft) east of subunit RV6A.

Unit RV7 for Limnanthes floccosa spp. grandiflora: Agate Lake, Jackson County, Oregon. (i) Unit RV7 consists of 421 ha (1,039 ac) of intact vernal pool–mounded prairie and swale habitat. The unit is located 500 m (1,640 ft) east of the Agate Reservoir, lies along a 5.4-km (3.4-mi) stretch roughly parallel and between Dry Creek and Antelope Creek, is 330 m (1,080 ft) north of Tater Hill, and is 1.4 km (0.9 mi) southeast of the confluence of Dry Creek and Antelope Creek.

Unit RV8 for Limnanthes floccosa ssp. grandiflora: Whetstone Creek, Jackson County, Oregon. (i) Unit RV8 consists of 344 ha (850 ac) of intact vernal pool–mounded prairie and swale habitat. The unit is located approximately 1.4 km (0.9 mi) southeast of the confluence of the Rogue River and Whetstone Creek, 2.2 km (1.4 mi) southwest of Tou Velle State Park, and 2.9 km southeast of the confluence of Bear Creek and the Rogue River. The unit roughly parallels a 2.6-km (1.6-mi) stretch of Whetstone Creek to the south.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Limnanthes floccosa ssp. grandiflora critical habitat consists of the following habitat components (75 FR 42490-42570):

(i) Vernal pools or ephemeral wetlands and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain Limnanthes floccosa ssp. grandiflora germination, growth, and reproduction, occurring in the Rogue River Valley vernal pool landscape. These vernal pools or ephemeral wetlands are seasonally inundated during wet years but do not necessarily fill with water every year due to natural variability in rainfall, and support native plant populations. Areas of sufficient size and quality are likely to have the following characteristics: (A) Elevations from 372 to 469 m (1,220 to 1,540 ft); (B) Associated dominant native plants including, but not limited to: Alopecurus saccatus, Deschampsia danthonioides, Eryngium petiolatum, Lasthenia californica, Myosurus minimus, Navarretia leucocephala ssp. leucocephala, Phlox gracilis, Plagiobothrys bracteatus, Trifolium depauperatum, and Triteleia hyacinthina. (C) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(ii) The hydrologically and ecologically functional system of interconnected pools, ephemeral wetlands, or depressions within a matrix of surrounding uplands that together form vernal pool complexes within the greater watershed. The associated features may include the pool basin or depressions; an intact hardpan subsoil underlying the surface soils up to 0.75 m (2.5 ft) in depth; and surrounding uplands, including mound topography and other geographic and edaphic features, that support these systems of hydrologically interconnected pools and other ephemeral wetlands (which may vary in extent depending on site-specific characteristics of pool size and depth, soil type, and hardpan depth).

(iii) Silt, loam, and clay soils that are of alluvial origin, with a 0 to 3 percent slope, primarily classified as Agate– Winlo complex soils, but also including Coker clay, Carney clay, Provig–Agate complex soils, and Winlo very gravelly loam soils.

(iv) No or negligible presence of competitive, nonnative, invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow Limnanthes floccosa ssp. grandiflora to continue to survive and recover.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and that may require special management considerations or protection. All areas we are designating as critical habitat require some level of management to address current and future threats to Limnanthes floccosa ssp. grandiflora, to maintain or enhance the physical or biological features essential to their conservation, and to ensure the recovery and survival of these species. The major threats to the PCEs in the areas identified as critical habitat for Limnanthes floccosa ssp. grandiflora include: development on private lands; mining activities; ground disturbance that affects surface hydrology, including ORV use and road construction or maintenance activities; incompatible agricultural and grazing practices; garbage dumping; the succession of meadow habitat to forested habitat due to fire suppression; and encroachment and displacement by nonnative plants. In all of the units in Jackson County, special management is needed to reduce or eradicate the threats posed by development, habitat fragmentation, ground disturbance that affects surface hydrology, and incompatible grazing practices. In all of the units in Josephine County, special management is needed to reduce or eradicate the threats posed by development, ORV use, mining activities, garbage dumping, and woody vegetative succession. Please refer to the unit descriptions in the Critical Habitat Designation section for further discussion of special management considerations or protection of the PCEs related to geographically specific threats to Limnanthes floccosa ssp. grandiflora. In addition, for all units, special management is needed to control and monitor the encroachment of nonnative, invasive plant species to maintain intact vernal pool–mounded prairies and wet meadow ecosystems such that they can continue to support populations of Limnanthes floccosa ssp. grandiflora. Special management considerations or protection of the vernal pool– mounded prairies and wet meadow habitats that may be needed to support reproduction and growth of Limnanthes floccosa ssp. grandiflora include: controlled burning and vegetation clearing to maintain early seral stages (early stages of plant succession in the progression toward a climax community); control of nonnative, invasive plant species; grazing management; the reestablishment of hydrology; re-seeding with native plants; monitoring; and protection from development (Borgias 2004, pp. 47–53; ONHDB 1994, pp. 13– 20). (USFWS, 2010)

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable (USFWS, 2016).

**Reproduction Narrative**

Adult: Meadowfoam produces one to three flowers per flower stalk; each flower will produce a cluster of 1 to 5 hard nutlets by mid-May that will quickly drop in the drying mud. Over much of its range, meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains. Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable. Nutlets are produced in late April, and the plants begin to die back by mid-May or when the soil becomes dry (Borgias 2004). Nutlets of meadowfoam apparently are dispersed by water; they can remain afloat for up to three days (USFWS 2012). However, the nutlets of the plant are normally dispersed only short distances. Thus, meadowfoam nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978) (USFWS, 2016).

**Habitat Type**

Adult: Vernal pools (USFWS, 2016)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Meadowfoam is endemic to vernal pool habitats within Jackson County, Oregon. The majority of the extant and historical sites for meadowfoam in the Rogue Valley occur on soil formations characterized by Agate-Winlo silty clay loam series (deep, poorly drained soils present in depressions in alluvial stream terraces) at elevations of 366 to 400 m (1,200 to 1,310 feet) (USFWS 2012). According to Arroyo (1973), the plant occurs generally near the wetter, inner edges of pools, as opposed to the drier outer fringes, which harbor the slightly more common L. floccosa ssp. floccosa (USFWS 2012). However, meadowfoam has been observed on the outside edges of vernal pools, sympatric with L. floccosa ssp. floccosa, and has even been observed in some areas on low upland mounds. The deeper basins are dominated by Plagiobothrys stipitatus, Eryngium petiolatum, Navarretia leucocephala ssp. leucocephala, and Myosurus minimus. Alopecurus saccatus (Pacific foxtail), and Deschampsia danthonioides are also common plant associates. The inner vernal pool edges occupied by meadowfoam often have up to 10 to 15% exposed soil, due partly to gopher or vole foraging activity (USFWS< 2016).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978) (USFWS, 2016).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2016)

**Population Growth Rate:**

Suspected. Decline of 30-50% (NatureServe, 2015)

**Number of Populations:**

23 (USFWS, 2024)

**Population Size:**

10,000 - 100,000 individuals  (NatureServe, 2015; USFWS, 2016))

**Additional Population-level Information:**

A total of 23 large-flowered woolly meadowfoam populations across the range of the species are documented as extant (ORBIC 2023, entire; USFWS 2024, entire). Of the 23 documented populations, 18 occur on property that can be accessed and monitored but 5 occur on private land that is inaccessible. Because of the inaccessibility of 5 populations, we cannot determine their status; however, based on recent aerial photography, the landscape appears intact, so we have no reason to believe the populations are extirpated. The 18 meadowfoam populations with consistent monitoring show that 13 populations are stable or increasing and 5 populations appear to be declining. For more detail on the population trend please see Appendix A. (USFWS, 2024)

**Population Narrative:**

Since the adoption of the 20 12 recovery plan, Limnanthes pumila ssp. grandiflora remains at 18 known populations (or occurrences) with two new populations documented and one population (Eagle Point) lost since 201 1 (Table 1) (Figure 1). In addition, a new population of 160 individual plants  t the PacificCorps Substation was discovered on City of Medford owned land, but also quickly became  extirpated during this period. The east Agate Desert, Whetstone Savannah, Highway 140, ODOT Dutton Road site, and Jackson Sports Park populations previously considered separate are combined herein due to their close proximity. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat degradation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Nearly 50% of Limnanthes pumila ssp. grandiflora sites have been severely altered (Meyers 2008). In 1999, a function and value assessment of vernal pool quality, abundance, and distribution determined that habitat with intact hydrology and only moderately altered vegetation accounted for just 3,600 acres or 17.6% of the original landform; approximately 2,104 acres of this contained well-distributed and abundant vernal pools (Oregon Natural Heritage Program 1999) (USFWS, 2016).

**Stressor:** Development (USFS, 2016).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road construction, housing, industrial and commercial development are listed as threats to this species. Other development in Medford, occurring in 2006, resulted in the loss of habitat (USFWS, 2016).

**Stressor:** ORV use (USFWS, 2016)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Off-road vehicle use is listed as a threat to this species. Recreational off-road vehicle activities have also impacted two meadowfoam populations in the White City area (USFWS, 2016).

**Stressor:** Dumping (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fill and contaminant dumping are listed as threats to this species (USFWS, 2016). Since 2002, a known meadowfoam population in the Agate Desert near Table Rocks Road was partially impacted due to disposal of contaminants (perhaps herbicide) that removed native vegetation from a 0.75 acre portion of vernal pools. The source of the spill was not determined (USFWS, 2016).

**Stressor:** Non-native plants (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasion of non-native annual grasses and herbs is listed as a threat to this species (USFWS, 2016).

**Stressor:** Herbicide spraying (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbicide spraying is listed as a threat to this species (USFWS, 2016).

**Stressor:** Livestock grazing (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Poorly managed livestock grazing is listed as a threat to this species (USFWS, 2016).

**Stressor:** Predation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** There is a potential threat of predation by meadowfoam fly (Scaptomyza apicalis) larvae (USFWS 2012). The meadowfoam fly, which occurs in northern California and Southern Oregon, is the only insect pest of significance on species of meadowfoam. The larvae of the meadowfoam fly have been known to cause severe damage to both vegetative and reproductive tissue in Limnanthes alba and may be present on meadowfoam in the Agate Desert, though the fly has not been observed (USFWS 2012) (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Reclassification from Endangered to Threatened status may be considered for Limnanthes pumila ssp. grandiflora when the following criteria are met: a. At least 16 of the 18 documented and extant occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

b. At least 90 percent of suitable vernal pool habitat acreage within the four Rogue Valley Priority 1 core areas has been protected, and at least 85 percent of suitable vernal pool habitat acreage within the five Rogue Valley Priority 2 core areas has been protected (see Tables IV-2 and IV-4 of the Recovery Plan). All suitable vernal pool habitat must include soils and hydrology that support Limnanthes pumila ssp. grandiflora. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations. (USFWS, 2010)

c. Management plans for each protected area are developed for species protection and conservation and implemented as soon as feasible. The management plans should address vegetation control, include a set of methods to reduce thatch buildup and noxious weed control, set a monitoring schedule to assess population levels to quantitatively determine trends, include a set of methods to maintain hydrological functions, outline an outreach plan for neighboring landowners, and set a plan to deter garbage dumping. Management plans should take an ecosystem approach to management, conserving associated wetland and upland species. (USFWS, 2010)

d. Additional Limnanthes pumila ssp. grandiflora occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined necessary to recovery are protected. (USFWS, 2010)

e. Achievement of self-sustaining Limnanthes pumila ssp. grandiflora populations within core areas will be determined through species monitoring and status surveys in each protected occurrence. In order to be considered self-sustaining, populations should demonstrate evidence of reproduction by seed set or presence of seedlings and exhibit population trends that are stable, increasing or show only minor declines from high population levels for 10 years prior to consideration for reclassification. (USFWS, 2010)

f. Seed collection is accomplished within each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4 of the Recovery Plan). (USFWS, 2010)

Recovery Priority Number: 3C

**Delisting Criteria:**

Delisting may be considered for Limnanthes pumila ssp. grandiflora when all downlisting criteria plus the following criteria are met: (USFWS, 2010)

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (e.g., evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats. (USFWS, 2010)

b. At least 17 of 18 Limnanthes pumila ssp. grandiflora occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support Limnanthes pumila ssp. grandiflora. Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4). (USFWS, 2010)

d. A post-delisting monitoring plan has been developed for Limnanthes pumila ssp. grandiflora . (USFWS, 2010)

**Recovery Actions:**

- 1. Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses. Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery core areas, while lower priority actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions. (USFWS, 2010)
- 2. Manage, monitor, and restore vernal pool and wet meadow habitat. Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation;

monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known Limnanthes pumila ssp. grandiflora populations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species. (USFWS, 2010)

- 3. Conduct rangewide population status surveys. A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site. (USFWS, 2010)
- 4. Conduct research essential to the conservation of these species. In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. Study pollination vectors between and among populations. Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors. Evaluate techniques to reduce impacts from encroachment of native woody plant succession. Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses. Refine research on appropriate grazing practices. Research genetic and morphologic traits among individuals and populations. Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill. Determine incidence of herbivory or predation on Limnanthes pumila ssp. grandiflora populations. Develop offsite and onsite cultivation and propagation techniques for Limnanthes pumila ssp. grandiflora. Research associated soil crusts as indicators for vernal pool health and function. (USFWS, 2010)
- 5. Enhance public awareness and participation in recovery of the species. Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the species. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans. Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved. Complete post-delisting monitoring plan for Limnanthes pumila ssp. grandiflora. (USFWS, 2010)
- Recommended Future Actions: Develop conservation easements or conservation programs for existing occurrences on private lands . Assist Jackson County School District #9 with habitat management for Limnanthes pumila ssp. grandiflora . Augment Limnanthes pumila ssp. grandiflora on protected habitat in the Rogue Airfield and North Eagle Point core areas • Assist the Bureau of Reclamation with Limnanthes pumila ssp. grandiflora habitat restoration • Conduct best management practices studies for Limnanthes pumila ssp. grandiflora. (USFWS, 2019)
- All of the General Plant Conservation Measures (Section 3.13.1) apply for meadowfoam. In additional, livestock grazing will not be used to control or remove invasive and non-native

vegetation at project sites occupied by large-flowered meadowfoam, unless approved by the local Service office. Also, this plant can be associated with vernal pool habitats, which can support Cook's desert parsley and vernal pool fairy shrimp (other listed species), and additional PDC, restrictions, and conservation measures may apply for vernal pool fairy shrimp (USFWS, 2016).

***Conservation Measures and Best Management Practices:***

- Recommendations for Future Actions: • While the majority of known large-flowered woolly meadowfoam populations have been protected, future conservation will need to continue to be reliant on private lands. For this reason, enhanced and targeted outreach to private landowners is needed for conservation partnership in key areas leading to protected areas contributing to recovery. Protection tools include conservation easements or conservation programs. • Augment large-flowered woolly meadowfoam on protected habitat in BOR's Agate Lake Reservoir property, Denman Wildlife Area, and protected habitat in the North Eagle Point core area. • Develop and implement surveillance for hybridization between white meadowfoam and large-flowered woolly meadowfoam. • Conduct best management practices studies such as grazing, seeding, mowing, and prescribed fire to improve resilience of large-flowered woolly meadowfoam populations (USFWS<, 2024)

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# SPECIES ACCOUNT: *Limnanthes vinculans* (Sebastopol meadowfoam)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 01/02/1992; Pacific Southwest (R8)

**Physical Description**

An annual herb of the false meadowfoam family (Limnanthaceae) with weak, somewhat fleshy, decumbent stems up to 30 cm (11.8 in) long (stems grow longest when the plant is submerged while actively growing). The seedlings are unusual among Limnanthes species in that they have entire leaves. Leaves of mature plants are up to 10 cm (3.9 in) long and have 3 to 5 leaflets that are narrow and unlobed with rounded tips. Although the first leaves are narrow and undivided, leaves on the mature plant have three to five undivided leaflets along each side of a long stalk (petiole). The length of the petiole also appears to be promoted by submergence. The shape of the leaves distinguishes L. vinculans from other members of the Limnanthes genus. Limnanthes vinculans has fragrant, white flowers during April and May. The flowers are borne in the leaf axils (upper angle between leaf and stem), are bell- or dishshaped, with petals 12 to 18 mm (0.47 to 0.71 in) long. The sepals (green outermost whorl of flower parts that enclose the bud) are shorter than the petals, which turn outward as the nutlets (small, dry nuts) mature. The nutlets are dark brown, 3 to 4 mm (0.12 to 0.16 in) long, and covered with knobby pinkish tubercles (small wartlike projections) (Ornduff 1969a, Brown and Jain 1977, Hauptli et al. 1978, Wainwright 1984, Patterson et al. 1994, Ornduff and Morin 2012). The seeds of L. vinculans germinate after the first significant rains in fall. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. (USFWS< 2016)

**Taxonomy**

The earliest collection of Limnanthes vinculans was made in 1946 “between Bodega and Petaluma, south of Sebastopol” but this record most likely represents a site near Sebastopol (Wainwright 1984). The species was not described until 1969, when Ornduff (1969a) officially published the name L. vinculans. Another common name for this species is Cunningham Marsh meadowfoam (Wainwright 1984, Patterson et al. 1994). The type locality for L. vinculans is Todd Road, just west of the intersection with Llano Road, which is near Sebastopol in Sonoma County (Ornduff 1969a). Limnanthes vinculans is similar to L. douglasii var. nivea (snowy meadowfoam) and L. alba (white meadowfoam) in flower characteristics, and to L. bakeri (Baker’s meadowfoam) in leaf characteristics. However, seedlings of L. douglasii and L. alba have lobed leaves and the mature leaves have more, deeper lobes called leaflets (5 to 13 leaflets as compared to 3 to 5 leaflets in L. vinculans). In addition, the petals of white meadowfoam curve inward as the nutlets mature. L. bakeri has smaller flowers than L. vinculans, occasionally has two or three lobes on the leaflets, and occurs only in Mendocino County (Ornduff and Crovello 1968, Ornduff 1969a, Brown and Jain 1977, Wainwright 1984, Ornduff and Morin 2013). (USFWS, 2016)

**Historical Range**

In California, in Sonoma and Napa Counties. (USFWS, 2016)

**Current Range**

In California, in Sonoma, Napa, and Lake Counties. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

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

**Lifespan**

Adult: One year (USFWS, 2016)

**Dependency on Other Individuals or Species**

Adult: Pollinators such as Conophorus flies and Limnanthes bees (USFWS, 2016)

**Key Resources Needed for Breeding**

Adult: Seed bank (USFWS, 2008); fall rains, insect pollinators (USFWS, 2016)

**Reproduction Narrative**

Adult: According to Patterson et al. (1994), the seeds of Limnanthes vinculans germinate after the first significant rains in fall, although late initiation of rains may delay seed germination. L. vinculans plants grow slowly underwater during the winter, and growth rates increase as the pools dry. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. L. vinculans begins flowering as the pools dry, typically in March or April. The largest plants can produce 20 or more flowers. Flowering may continue as late as mid-June, although in most years the plants have set seed and died back by then. Each plant can produce up to 100 nutlets. Nutlets of Limnanthes vinculans likely remain dormant in the soil, as has been noted in other species of Limnanthes (Patterson et al. 1994). For example, in the late 1980s and early 1990s, a site in Cotati remote from other L. vinculans occurrences was surveyed for several years by independent qualified botanists. None of these botanists identified flowering occurrences of L. vinculans on the project site. Conditions of the pools on the site were highly degraded by wallowing hogs (Sus scrofa) and subsequent eutrophication (over enrichment by nutrients) of the pools. Following several years of negative surveys, 12 plants of Sebastopol meadowfoam emerged simultaneously in one pool in the first year following removal of hogs. (USFWS, 2016)

**Habitat Type**

Adult: Wetland (USFWS, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Northern Basalt Flow and Northern Hardpan vernal pools (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: 50 - 380 ft. elevation (USFWS, 2016)

**Spatial Arrangements of the Population**

Adult: Linear, patchy (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Dependency on Other Individuals or Species for Habitat**

Adult: Wetland obligate

**Habitat Narrative**

Adult: This species grows in northern basalt flow and northern hardpan vernal pools (Sawyer and Keeler-Wolf 1995), wet swales and meadows, on the banks of streams, and in artificial habitats such as ditches (Wainwright 1984; CNDDB 2002). Limnanthes vinculans grows in both shallow and deep areas, but is most frequent in pools 25 to 51 cm (10 to 20 in) deep (Patterson et al. 1994). The species is most abundant in the margin habitat at the edge of vernal pools or swales (Pavlik et al. 2000, 2001). Most confirmed occurrences of L. vinculans on the Plain grow on Wright loam or Clear Lake clay soils (Patterson et al. 1994, CNDDB 2002). A few occurrences are on other soil types, including Pajaro clay loam, Cotati fine sandy loam, Haire clay loam (Patterson et al. 1994) and Blucher fine sandy loam (Wainwright 1984). (USFWS, 2016)

***Dispersal/Migration***

**Dispersal**

Adult: Low, based on closely related species (USFWS, 2016)

**Dispersal/Migration Narrative**

Adult: Mechanisms for dispersal of nutlets in this species have not been studied. Likely dispersal agents include water (Wainwright 1984), birds, and livestock (Jain 1978). Jain (1978) studied dispersal of nutlets similar to those of L. vinculans in two species of meadowfoam, L. bakeri (Baker's meadowfoam) and L. striata (striped meadowfoam). Nutlets of L. bakeri did not disperse beyond the point where they were placed. Nutlets of L. striata moved a short distance within the same pool where they were placed but did not disperse to other pools (Hauptli et al. 1978, Jain 1978). (USFWS, 2016)

***Population Information and Trends***

**Population Trends:**

90% of vernal pool habitat destroyed (NatureServe, 2015)

**Species Trends:**

Primarily unknown or decreasing (USFWS, 2008)

**Number of Populations:**

38 presumed extant (USFWS, 2024)

**Population Size:**

1,000's (USFWS, 2024)

**Additional Population-level Information:**

At the time of listing in 1991, Sebastopol meadowfoam was documented in 29 locations in the southwestern portion of the Santa Rosa Plain, previously referred to as the Cotati Valley, in Sonoma County (B. Guggolz, California Native Plant Society, pers. comm. 1990, as cited in Service 1991, p. 61174). The 2008 status review defined distribution according to the Diversity Database, in which Sebastopol meadowfoam was known from 40 occurrences in Sonoma County and one occurrence (#39) in Napa County at the Napa River Ecological Reserve (Service 2008, p. 4). The Napa County occurrence was discovered in 1993, after publication of the final listing rule in Service 1991 (Diversity Database 2024, p. 39). In Sonoma County, 38 occurrences were in central and southern Santa Rosa Plain, while the other two were in Atascadero Creek Marsh west of Sebastopol (#20) and in Knights Valley northeast of Windsor (#40) (Diversity Database 2001, as cited in Service 2008, p. 4). As noted in the 2019 status review, one additional occurrence (#53) was found in Napa County, southeast of the City of Calistoga, and two occurrences were found in Sonoma County near the City of Sebastopol (#54) and the City of Rohnert Park (#55) (Service 2019, p. 4). Two additional occurrences (#56 and #57) were introduced in Sonoma County during mitigation activities or to establish conservation banks. Another change made to the Diversity Database is the removal of occurrence #55 in June 2020 due to misidentification (K. Ferguson, California Department of Fish and Wildlife, in litt. 2024). The occurrence was observed in 2012 and identified as Sebastopol meadowfoam based on early blooming plants (M. Lang, Dudek, in litt. 2020). Verification later in the blooming period revealed that the plants were misidentified and were Douglas' meadowfoam; however, the occurrence was not removed from the Diversity Database until 2020 (Lang in litt. 2020). The final change in distribution since the previous status review is the status change of occurrence #35 from "possibly extirpated" to "extirpated". The occurrence was last observed in 1998 and is presumed to be extirpated by development, based on aerial imagery (Diversity Database 2024, p. 35). Seeds were collected from this occurrence in 1993, 1994, 1997, and 1998 and sown at occurrence #34 (Diversity Database 2024, p. 35). Of the 46 occurrence records currently described in the Diversity Database, three are considered "extirpated", five are "possibly extirpated", and the remaining 38 are "presumed extant" (USFWS, 2024)

**Population Narrative:**

The available vernal pool habitat is limited as 90% of the vernal pool habitat has been destroyed by urbanization or agricultural development (CPC 2006) (NatureServe, 2015). Populations can vary greatly in size from year to year. Patterson et al. (1994) estimated only 10 hydrologically separate populations of L. vinculans exist. The CNDDB (2008) reports 32 extant occurrences, with the trend for most occurrences either unknown or decreasing. The genetic variability of Limnanthes vinculans is low compared to other Limnanthes species (Jain 1984). However, populations of this species do differ in genetic makeup (Jain in litt. 1980) (USFWS, 2008). The current status of numerous Limnanthes vinculans occurrences is unknown; however, the most current information from CNDDB, from survey data collected by the Adopt-a-Vernal Pool program, and from species experts indicates that there are 37 occurrences of L. vinculans that are presumed extant of which at least three have been introduced (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Development and conversion to agriculture (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

**Stressor:** Alteration of hydrology (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

**Stressor:** Off-highway vehicles (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Damage by off-highway vehicles was noted as a threat to this species. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

**Stressor:** Grazing managment and thatch accumulation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (Phalaris aquatica), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

**Stressor:** Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are

proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

**Stressor:** Climate change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including B. bakeri, L. burkei, and L. vinculans. (USFWS< 2016)

**Stressor:** Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Chance events constitute a serious threat to Blennosperma bakeri. Because the known occurrences of B. bakeri are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998). (USFWS, 2016)

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

**Stressor:** Non-native invasive species (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce

more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

**Stressor:** Pesticides (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. Sebastopol meadowfoam is primarily pollinated by its specialist bee, Andrena pulvera, but it is also visited by a diversity of other bees and syrphid flies (Gilmore 2018, pp. 4, 54–57). The Agency's final biological evaluations determined that all three pesticides are highly toxic to bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Sebastopol meadowfoam, there is a potential for the three pesticides to indirectly adversely affect the species (Agency 2022a, p. 4; Agency 2022b, p. 2; Agency 2022c, p. 3). The Agency anticipates releasing amended proposed interim decisions and a national consultation with the Agency is currently pending (USFWS, 2024).

**Stressor:** Genetics (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, the species' gene flow was disrupted by habitat fragmentation. Now, gene flow is altered by mitigation activities and human-facilitated movement of seeds among populations. The 2019 status review confirms the threat of disruption of gene flow and change in flow patterns due to habitat restoration activities, based on new information from Halbur et al. (2014) (Service 2019, p. 4). Mitigation activities for Sebastopol meadowfoam, including vernal pool creation with seed inoculation, is concentrated in the center of the species range (Halbur et al. 2014, p. 681). Halbur et al. (2014) found enhanced gene flow at the center of the range due to establishment of new habitat and occurrences (p. 691). As a result, individuals in created pools are more genetically similar than individuals in natural pools separated by similar distances (Halbur et al. 2014, p. 691). In contrast, the population at a particular mitigation site known as Slippery Rock exhibits the opposite genetic dynamics (i.e., more genetic differentiation from surrounding sites), as the seeds were translocated from the northern range boundary to the center of the range (Halbur et al. 2014, p. 692). This is a potential barrier to gene flow due to outbreeding depression (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
A/1: Of all extant, native occurrences in the Plain not protected as of December 2014, 75 percent of the Limnanthes vinculans Northern Core Area occurrences, and 80 percent of the

Limnanthes vinculans Southern Core Area occurrences are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that have been shown to be isolated and/or genetically unique. (USFWS, 2016)

A/2: New preserves protect a total of 500 ac in two general areas: 200 ac in the Limnanthes vinculans Northern Core Area and 300 ac in the Limnanthes vinculans Southern Core Area. These preserves consist of occupied habitat that was not protected as of December 2014. The ecological integrity (e.g., water quality, hydrology, and uplands condition) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses is sufficient to ensure that there are no significant adverse effects to Limnanthes vinculans, such as changes in hydrology or contamination by pesticides or herbicides, currently and into the foreseeable future (USFWS, 2016).

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences may be less than 10 ac. The preserves should be as near to new or existing preserves as possible. (USFWS, 2016)

A/4: The total new preserve acreage among all core areas consists of a minimum of 70 ac of vernal pools and swales (40 ac in the Limnanthes vinculans Northern Core Area and 30 ac in the Limnanthes vinculans Southern Core Area). However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: All native occurrences, extant as of December 2014, in the Limnanthes vinculans Northern Core Area as well as the Theiller (owned by CDFW) and Haroutounian (owned by Sonoma County Open Space) sites in the southern portion of the Limnanthes vinculans Southern Core Area, are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected appropriate sites. The remaining occurrences in Limnanthes vinculans Southern Core Area are replicated at 1:1 because they are genetically similar. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016).

E/2: The preserves noted in Factor A are occupied by Limnanthes vinculans at a density of 1,500 seeds per square meter when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrences of the listed plants and climate change, are developed and are being effectively implemented. (USFWS, 2016)

Recovery Priority Number: 2C

**Delisting Criteria:**
A/1: At least ninety percent of all known occurrences of Limnanthes vinculans that are extant as of December 2014, have been protected in perpetuity. (USFWS, 2016)

E/1: In addition to replication noted in criterion 7 of the downlisting criteria for Limnanthes vinculans, all occurrences in management areas have been replicated at 1:2 at permanently protected at appropriate locations. (USFWS, 2016)

E/2: All replicate occurrences in management areas have achieved the same density (1,500 seeds per square meter) as the core area occurrences. (USFWS, 2016)

E/3: If Limnanthes vinculans is found at the Knights Valley site, the northernmost location, this occurrence should be replicated at 1:2 in permanently protected appropriate locations. (USFWS, 2016)

E/4: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6 of the Recovery Plan. (USFWS, 2016)

**Recovery Actions:**
- 1. Protect extant occurrences and potential habitat for Limnanthes vinculans. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of Limnanthes vinculans including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).

- 3. Collect and store seed from all occurrences of Limnanthes vinculans. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
- 4. Survey historical locations and other potential habitat (not previously surveyed) where Limnanthes vinculans may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for Limnanthes vinculans. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on Limnanthes vinculans and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of Blennosperma bakeri, Lasthenia burkei, and Limnanthes vinculans. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for Limnanthes vinculans. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of

management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. Blennosperma bakeri and Limnanthes vinculans at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)

- 10. Engage and educate the public about Limnanthes vinculans recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)

**References**

USFWS. 2019. Sonoma sunshine (Blennosperma bakeri), Burke’s goldfields (Lasthenia burkei) and Sebastopol meadowfoam (Limnanthes vinculans)

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USFWS. 2016. Recovery Plan for the Santa Rosa Plain: Blennosperma bakeri (Sonoma sunshine)

Lasthenia burkei (Burke’s goldfields)

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USFWS. 2024. 5-YEAR REVIEW Sebastopol meadowfoam (Limnanthes vinculans). Sacramento Fish and Wildlife Office, Sacramento, California. 15 pp.

5-Year Review. U.S. Fish and Wildlife Service, Sacramento, California. May 1, 2019. 12 pp. https://ecos.fws.gov/docs/five_year_review/doc6010.pdf

# SPECIES ACCOUNT: *Linum arenicola* (Sand flax)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/31/2016; Southeast Region (R4)(USFWS, 2017)

**Physical Description**

Linum arenicola is a small, perennial herb that is 35 to 53 cm (14 to 21 in) tall with yellow flowers that are similar in appearance those of a buttercup (Ranunculus spp.). When not in flower, it resembles a short, wiry grass. Plants have one to several stems arising from their base. Leaves are linear in shape, 7– 10 millimeters (mm) (0.3–0.4 in) long, 0.6–1 mm (0.02–0.04 in) wide, and arranged alternately along stems, and they have glands scattered along their edges. Flowers are produced on stems consisting of a few slender, spreading branches. The individual flowers are on small stalks 2 mm (0.08 in) long or shorter. The flowers have five yellow, egg-shaped petals that are 4.5–5.5 mm (0.18–0.22 in) long, and five green, lance-shaped to egg-shaped sepals that are 2.4–3.2 mm (0.09–0.13 in) long. The seeds are ovate, 1.2– 1.4 mm (0.05–0.06 in) long, and 0.7- 0.8 mm (0.027–0.031 in) wide (Rogers 1963, pp. 103–104) (USFWS, 2015). The fruit is an elongate pod, roughly similar to that of a pea, 33–45 millimeters (mm) (1.3–1.8 inches (in)) long and 4.5–5.0 mm (0.19–0.17 in) wide, with a soft fuzzy texture, which turns gray with age and eventually splits open to release seeds (Irwin and Barneby 1982, p. 757; Small 1933, pp. 662–663) (USFWS, 2016).

**Taxonomy**

Linum arenicola was first described by Small in 1907 as Cathartolinum arenicola from plants he collected in Miami-Dade County in 1904. This treatment was consistently followed by Small (1913a, p. 69; 1913b, p. 96; 1933, p. 752). In 1931, Winkler included Cathartolinum within the genus Linum, renaming the plants Linum arenicola (Winkler 1931, p. 30). Others have followed this treatment, including Rogers (1963, p. 103), Long and Lakela (1971, p. 505), Robertson (1971, p. 649), Wunderlin (1998, p. 100), and Wunderlin & Hansen (2003, p. 100) (Hodges and Bradley 2006, p. 37). Synonyms include Cathartolinum arenicola Small (Wunderlin and Hansen 2004, p. 5). The Integrated Taxonomic Information System (2015, p. 1) uses the name Linum arenicola and indicates that this species' taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name L. arenicola. There is consensus that L. arenicola is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon (USFWS, 2015).

**Historical Range**

The historical range of Linum arenicola consists of central and southern Miami-Dade County and Monroe County in the lower Florida Keys (Bradley and Gann 1999, p. 61). In Miami-Dade County, records for the species were widespread from the Coconut Grove area to the southern part of the County, close to what is now the main entrance to Everglades National Park and Turkey Point (Bradley and Gann 1999, p. 61). In the Florida Keys (Monroe County), there are records of the species from Big Pine Key, Ramrod Key, Upper and Lower Sugarloaf Keys, Park Key, Boca Chica Key, Middle Torch Key (Bradley and Gann 1999, p. 61), and Big Torch Key (Hodges 2010, p. 10) (USFWS, 2015).

**Current Range**

The current range of Linum arenicola consists of eight extant populations in Miami-Dade County and four islands in the Florida Keys: Big Pine Key, Upper and Lower Sugarloaf Keys, and Big Torch Key (USFWS, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual

**Breeding Season**

Adult: Flowers are produced from February to September, with a peak around March and April

**Reproduction Narrative**

Adult: Little is known about the life history of Linum arenicola, including pollination biology, seed production, or dispersal. Reproduction is sexual, with new plants generated from seeds. The species produces flowers from February to September, with a peak around March and April. L. arenicola population demographics or longevity have not been studied (Bradley and Gann, 1999, p. 65; Hodges and Bradley 2006, p. 41; Hodges 2007, p. 2).

**Habitat Type**

Adult: Temporary pools; Forest/Woodland, Old field, Woodland - Conifer, Woodland - Mixed

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: Pine Rocklands: Linum arenicola occurs in pine rocklands, disturbed pine rocklands, dry marl prairie, and disturbed areas on rocky soils adjacent to these habitats (Bradley and Gann 1999, p. 61; Hodges and Bradley 2006, p. 37). L. arenicola grows in thin soil over limestone or in small soil patches caught in surface irregularities of exposed limestone (Kernan and Bradley, 1996, p. 2). Sites most likely to support L. arenicola have a grass- and herbdominated understory, abundant pine regeneration, and high cover of exposed rock (Ross and Ruiz 1996, pp. 5–6). The pine rocklands and marl prairies where this species occurs require periodic fire to maintain an open, shrub-free subcanopy, and to reduce litter levels (Bradley and Saha 2009, p. 4). Pine rocklands habitat is described in detail for Chamaecrista lineata var. keyensis, above. Roadsides and Other Disturbed Sites: While pine rocklands historically were the primary habitat of Linum arenicola, the species is currently rare in relatively undisturbed pine rocklands, with the exception of plants on Big Pine Key. Several occurrences are in scraped (scarified) pine rocklands remnants that are dominated by native pine rocklands species, but have little or no pine canopy or subcanopy (Bradley and Van Der Heiden 2013, pp. 9–12). Two populations in Miami-Dade County occur entirely on levees composed of crushed oolitic limestone that are surrounded by sawgrass marsh (Bradley and Gann 1999, p. 61; Bradley and Van Der Heiden 2013, pp. 7–9). Roadsides and other disturbed sites are important habitat for L. arenicola because they imitate upland herbaceous habitat (Hodges and Bradley 2006, p. 40). The most robust roadside populations occur in areas adjacent to pine rocklands or rockland hammocks (Hodges 2010, p. 3). Where L. arenicola is found on roadsides, the ground cover is dominated mostly by native herbs and grasses where exotic lawn grasses have not been planted (Bradley 2006, p. 37). Infrequent mowing of some roadsides, and of disturbed sites such as Homestead Air Reserve Base (HARB) and U.S. Special Operations Command South Headquarters (SOCSOUTH), a unified command of all four services in the Department of Defense (DOD) has likely allowed the species to persist by preventing these sites from being taken over by hardwoods. Because Linum arenicola seems to only rarely occur within intact pine rocklands, but more frequently adjacent to this habitat, developing conservation and management plans for this species is exceptionally difficult. Its persistence on roadsides is not fully understood. L. arenicola was at one time more common in pine rocklands in Miami-Dade County, but a lack of periodic fires in most pine rocklands fragments over the last century have pushed this species into more sunny, artificial environments (Bradley and Gann 1999, p. 61). It is also possible that the species has evolved to persist along roadsides as fire regimes and natural areas were altered and destroyed over the last century (Hodges and Bradley 2006, p. 41). Dry Marl Prairie: Marl prairie is a sparsely vegetated, grass-dominated community found on marl substrates in South Florida. Marls are fine, white, calcareous muds formed from calcite precipitated by a mixture of green algae, blue green algae, and diatoms, known as periphyton. It is seasonally inundated (2 to 4 months) to a shallow depth averaging about 20 cm (8 in). Marl prairie is a diverse community that may contain over 100 species. Marl prairie normally dries out during the winter and is subject to fires at the end of the dry season (FNAI 2010, p. 1). Occurrences reported from marl prairie are at sites that have been artificially drained (Bradley and Van Der Heiden 2013, p. 11), or are scraped pine rocklands that function more like marl prairie (Kernan and Bradley 1996, p. 11). As with roadside populations of Linum arenicola, it is possible that dry marl prairies have become refugia for the species as fire regimes and natural areas were altered and destroyed over the last century. Accordingly, the Service does not consider marl prairie to be a primary habitat for L. arenicola (USFWS, 2015).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

In the 5 populations where data are sufficient to assess trend, 3 appear stable and 2 appear declining

**Number of Populations:**

15 extant; 14 presumed extant (USFWS, 2024)

**Population Narrative:**

The large area of potential habitat and scarcity and diminutive size of L. arenicola make thorough surveys for this species difficult (Hodges and Bradley 2006, p. 37). Based on a compilation of all survey work through 2013, including Austin (1980), Kernan and Bradley (1996, pp.1– 30), Bradley and Gann (1999, pp. 61– 65), Hodges and Bradley (2006, pp. 37– 41), Bradley and Saha (2009, p. 10), Bradley (2009, p. 3), Hodges (2010, pp. 4–5, 15), Bradley and van der Heiden (2013, pp. 6–12,19), and Bradley et al. (2015, pp. 28–29), of 26 historical population records for Linum arenicola, 12 populations are extant and 14 are extirpated, a loss of roughly

54 percent of known populations, from the early 1900s to the present. reliable population trends can be derived from past surveys for 5 of the 12 extant populations. Populations on Big Pine Key and Big Torch Key have shown clear declines. Three populations appear to be stable (data suggest they have not declined appreciably). Data are insufficient to determine trends for the remaining seven populations. The data also show that 5 of the 12 extant populations are rather small, having fewer than 100 plants. Currently there are 15 extant populations and 14 presumed extirpated populations (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat loss, fragmentation, and degradation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss, fragmentation, and degradation, and associated pressures from increased human population, are major threats; these threats are expected to continue, placing these plants at greater risk. The species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitat conditions. Any populations of this species found on private property could be destroyed by development; the limited pine rocklands, rockland hammock, and coastal berm habitat on public lands can also be affected by development of recreational facilities or infrastructure projects. Although efforts are being made to conserve publicly and privately owned natural areas and apply prescribed fire, the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat. Therefore, based on the best information available, we have determined that the threats to the species from habitat destruction, modification, or curtailment are occurring throughout the entire range of the species and are expected to continue into the future (USFWS, 2015).

**Stressor:** Disease or Predation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** No diseases or incidences of predation have been reported for Chamaesyce deltoidea ssp. serpyllum or Argythamnia blodgettii. Key deer are known to occasional browse plants indiscriminately, including Chamaecrista lineata var. keyensis and Linum arenicola. Key deer do not appear to feed on Argythamnia blodgettii, probably due to potential toxicity (Hodges and Bradley 2006, p. 19). Seed predation by an insect occurs in Chamaecrista lineata var. keyensis, and seems to be exacerbated by habitat fragmentation. Individuals at the urban edge suffer higher insect seed predation than those inside the forest (Liu and Koptur 2003, p. 1184). While seed predation and occasional Key deer browsing may be a stressor, they do not appear to rise to the level of threat at this time. Therefore, the best available data do not indicate that disease or predation is a threat to Chamaecrista lineata var. keyensis or Linum arenicola (USFWS, 2015).

**Stressor:** The Inadequacy of Existing Regulatory Mechanisms (USFWS, 2015)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Currently, Chamaecrista lineata var. keyensis, Chamaesyce deltoidea ssp. serpyllum, Linum arenicola, and Argythamnia blodgettii are found on Federal, State, and County lands; however, there is no regulatory mechanism in place that provides substantive protection of habitat or protection of potentially suitable habitat at this time. NPS and USFWS Refuge regulations provide protection at ENP and the Florida Keys Wildife Refuge Complex, respectively. The Act provides some protection for candidate species on NWRs and during intraService section 7 consultations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The NFC program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations (as described above) that reduce its ability to protect the four plants and their habitats. Although many populations of the four plants are afforded some level of protection because they are on public conservation lands, existing regulatory mechanisms have not led to a reduction or removal of threats posed to these plants by a wide array of sources (see discussions under Factor A, above, and Factor E, below) (USFWS, 2015).

**Stressor:** Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** We have analyzed threats from other natural or manmade factors including: nonnative, invasive plants; management practices used on roadsides and disturbed sites (such as mowing, sodding, and herbicide use); pesticide spraying and its effects on pollinators; environmental stochasticity; effects from small population size and isolation; and the effects of climate change, including SLR. The related risks from hurricanes and storm surge act together to impact populations of all four plants. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and county land managers. Many of the remaining populations of these plants are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants (USFWS, 2015).

***Recovery***

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

Recovery Priority Number: 5

***Conservation Measures and Best Management Practices:***

- Recovery Activities • Work with land managers to incorporate conservation mowing regimes beneficial to the species. • Conduct or continue to conduct habitat restoration on all occupied sites, including (a) removal of native hardwoods and non-native invasive plants and (b) establish a prescribed burn or mowing regimen. • Coordinate with the South Florida Water Management District (SFWMD) and other partners conducting Everglades restoration projects in and around the L-31E and nearby intersecting canals to ensure that sand flax is not impacted or that mitigation occurs. • Develop a captive propagation and reintroduction plan for the species that assesses risks and guides future introductions. o Determine if translocations may be beneficial to occupy suitable habitat. o Assess reintroduction locations where sand flax has been extirpated. o Consider prioritizing augmenting populations that have less than ten plants to ensure population survival and genetic exchange. o Assess collections currently in seed banks and prioritize new locations for collection for seed banking with a focus on those that are not yet represented or are under-represented in storage. • Establish best horticultural practices for ex situ cultivation. • Acquire land or develop conservation agreements in occupied habitat or unoccupied suitable habitat. • Rescue sand flax in cases where development is scheduled. • Discuss potential for reducing pesticides use in and around areas with this species with local mosquito control districts. Monitoring and Research Activities • For all populations with fewer than 100 individuals, monitor at least once per year. • Research the possibility of hybridization with other species of Linum, namely L. medium and L. floridanum before reintroduction to northern portions of the range. • Conduct genetic research to determine the amount of genetic variation between and within populations. • To determine how long viability is retained in storage, re-test seeds that Fairchild has banked at 5 years and repeat tests every 5 years thereafter. • Further investigate impacts of pesticides on pollination rates. Outreach Activities • Increase public awareness and appreciation for native plants and habitats. o Attend public events when appropriate to improve community understanding of management techniques and policies, such as prescribed fire, in pine rockland habitats (USFWS, 2024).

**References**

USFWS. 2015. Endangered Species Status for Chamaecrista Lineata Var. Keyensis (Big Pine Partridge Pea), Chamaesyce Deltoidea Ssp. Serpyllum (Wedge Spurge), and Linum Arenicola (Sand Flax), and Threatened Species Status for Argythamnia Blodgettii (Blodgett's Silverbush)

Proposed Rule. 80 FR 58536-58567 (September 29, 2015).

USFWS. 2016. Endangered Species Status for Chamaecrista lineata var. keyensis (Big Pine Partridge Pea), Chamaesyce deltoidea ssp. serpyllum (Wedge Spurge), and Linum arenicola (Sand Flax), and Threatened Species Status for Argythamnia blodgettii (Blodgett's Silverbush)

Final Rule. 81 FR 66842 - 66865 (September 29, 2016).

Proposed Rule. 80 FR 58536-58567 (September 29, 2015).

Proposed Rule. 80 FR 58536-58567 (September 29, 2015). USFWS. 2024. Sand Flax (Linum arenicola) 5-Year Status Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 16 pp.

USFWS. 2024. Sand Flax (Linum arenicola) 5-Year Status Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 16 pp.

# SPECIES ACCOUNT: *Linum carteri carteri* (Carter's small-flowered flax)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/06/2014; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Annual or short-lived perennial herb with an erect stem, 230–360 millimeters (mm) (9.0–14.2 inches (in)) tall, commonly branched near the base and puberulent (covered with minute hairs). Its leaves are slender (18–26 mm (0.7–1.0 in) long and 0.8–1.2 mm (0.03– 0.05 in) wide), entire, alternate, and closely overlap at the base of the plant. This variety has stipules with paired dark glands. Its inflorescence is an ascending or spreading cyme (usually flat-topped or convex flower cluster in which the main axis and each branch end in a flower that opens before the flowers below or to the side of it), with yellow petals that are broadly obovate (egg-shaped), 9–17 mm (0.35– 0.67 in) long, and quickly deciduous. The fruit is straw-colored, ovoid, 4.1– 4.6 mm (0.16–0.18 in) long, 3.4–3.7 mm (0.13–0.15 in) in diameter, and dehisces (opens spontaneously at defined places) into five two-seeded segments; seeds are narrowly ovoid-elliptic, 2.3–2.8 mm (0.09–0.11 in) long, 1.0–1.3 mm (0.04– 0.05 in) wide. In habit and flower, the plant closely resembles Piriqueta cistoides ssp. caroliniana (pitted stripeseed) in the family Turneraceae (USFWS, 2014).

**Taxonomy**

In the order Laurales, family Lauraceae (Flax family). Linum carteri was named by Small in 1905; in 1907, he put it in a segregate genus, calling it Cathartolinum carteri. In 1963, Rogers renamed the plants as a variety of Linum rigidum, noting the close relationship of Florida plants to those in the Western United States. In 1968, he split the taxon into two varieties, calling pubescent plants Linum carteri var. carteri, and segregating the glabrous plants as Linum carteri var. smallii, basing the division on new genetic data from Mosquin and Hayley (1967) and his own morphological data (Bradley and Gann 1999). L. c. var. carteri was treated as endemic to Miami-Dade County, while L. c. var. smallii was slightly more widespread in southern Florida . ITIS (2013) uses the name Linum carteri var. carteri and indicates that this species' taxonomic standing is accepted. Based upon the best available scientific information, Linum carteri var. carteri is a distinct taxon, endemic to Miami-Dade County in Florida. (USFWS, 2013)

**Historical Range**

First collected in 1903 between the Coconut Grove and Cutler areas of Miami, Florida, and since that time, it has been found in pine rocklands from as far north as the Brickell Hammock area to as far south as the Naranja area (USFWS, 2013).

**Current Range**

Currently found in eastern Miami-Dade County, Florida, from R. Hardy Matheson Preserve (near Pinecrest) southwest to Naranja/ Modello, with a distance of approximately 27.3 km (17 mi) between the farthest locations (USFWS, 2013).

**Critical Habitat Designated**

Yes; 9/16/2015.

**Legal Description**

On August 17, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 16, 2015) for Linum carteri carteri (Carter's small-flowered flax) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Florida (80 FR 49846-49886).

**Critical Habitat Designation**

The critical habitat designation for Linum carteri carteri includes seven CHUs (49 sub-units) in Miami-Dade County, Florida. This species critical habitat encompasses approximately 2,706 acres (ac) (1,095 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 49846-49886)

Unit LCC1: Trinity Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit LCC1 consists of 19 ac (48 ha) in Miami-Dade County. Within Unit LCC1, there are three subunits—LCC1A and LCC1B (primarily County-owned), and LCC1C (combination of State lands and private ownership). The unit is comprised of State lands within Trinity Pineland County Park (4 ac (10 ha)); County lands primarily within Tropical Park and A. D. ‘‘Doug’’ Barnes Park (7 ha (18 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 24 Street, on the south by the Snapper Creek Expressway (State Road (SR) 878), on the east by SW 67 Avenue, and on the west by SW 87 Avenue.

Unit LCC2: Nixon Smiley Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit LCC2 consists of approximately 113 ha (278 ac) of habitat in MiamiDade County. Within Unit LCC2, there are six subunits (LCC2A–LCC2F) comprising primarily conservation lands and including four larger areas plus two smaller areas. The unit is comprised of State lands within Camp Matecumbe, Tamiami Pineland Complex Addition, and Rockdale Pineland (53 ha (131 ac); County/local lands within Nixon Smiley Pineland Preserve, Tamiami #8 (Nixon Smiley Addition) Pineland, Pine Shore Pineland Preserve, Ron Ehman Park, and Rockdale Pineland Addition (59 ha (147 ac)); and parcels in private or other ownership (<1 ha (<1 ac)). This unit is bordered on the north by SW 104 Street, on the south by SW 152 Street (Coral Reef Drive), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit LCC3: USDA Subtropical Horticultural Research Station and Surrounding Areas, Miami-Dade County, Florida: Unit LCC3 consists of approximately 128 ha (316 ac) of habitat in MiamiDade County. Within Unit LCC3, there are nine subunits (LCC3A–LCC3I), including two larger areas (USDA and Deering Estate at Cutler) plus seven smaller areas surrounding these. The unit is comprised of Federal lands within the USDA Subtropical Horticultural Research Station (59 ha (145 ac)); State lands within the R. Hardy Matheson Preserve, Ludlam Pineland, Deering Estate at Cutler, and Deering Estate South Addition (45 ha (112 ac)); County/local lands within Coral Reef Park, Ned Glenn Nature Preserve, and Bill Sadowski Park (15 ha (38 ac)); and parcels in private ownership (8 ha (21 ac)). This unit is bordered on the north by SW 112 Street, on the south by the intersection of Old Cutler Road and Franjo Road (County Road (CR) 977), on the east by the Atlantic Ocean, and on the west by U.S. 1 (South Dixie Highway).

Unit LCC4: Richmond Pinelands and Surrounding Areas, Miami-Dade County, Florida: Unit LCC4 consists of approximately 386 ha (952 ac) in Miami-Dade County. Within Unit LCC4, there are four subunits (LCC4A–LCC4D), primarily within the Richmond Pinelands complex (made up of Federal and County-owned lands, as well as land owned by the University of Miami). The unit is comprised of Federal lands owned by USCG, ACOE, U.S. Prison Bureau, and NOAA (75 ha (185 ac)); County/local lands within and adjacent to Larry and Penny Thompson Park, Martinez Pineland, Zoo Miami, and Eachus Pineland (240 ha (592 ac)); and parcels in private or other ownership (71 ha (175 ac)). This unit is bordered on the north by SW 152 Street (Coral Reef Drive), on the south by SW 200 St (Quail Drive/SR 994), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit LCC5: Quail Roost Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit LCC5 consists of approximately 98 ha (242 ac) in Miami-Dade County. Within Unit LCC5, there are 10 subunits (LCC5A–LCC5J), including 4 larger areas plus 6 smaller areas surrounding these. The unit is comprised of State lands within Quail Roost Pineland, Goulds Pineland and Addition, and Silver Palm Groves Pineland (39 ha (97 ac)); County/ local lands including Medsouth Park, Black Creek Forest, Rock Pit #46, and lands owned by the School Board of Miami-Dade County (18 ha (44 ac)); and parcels in private ownership (41 ha (101 ac)), including Porter-Russell Pineland owned by the Tropical Audubon Society. This unit is bordered on the north by SW 200 St (Quail Drive/SR 994), on the south by SW 248 Street, on the east by the Florida Turnpike, and on the west by SW 194 Avenue.

Unit LCC6: Camp Owaissa Bauer and Surrounding Areas, Miami-Dade County, Florida: Unit LCC6 consists of approximately 128 ha (315 ac) of habitat in MiamiDade County. Within Unit LCC6, there are 21 subunits (LCC6A–LCC6U), composed of 1 larger area (Camp Owaissa Bauer and its addition) and 20 smaller areas surrounding it. The unit is comprised of State lands within Owaissa Bauer Pineland Addition, Ingram Pineland, West Biscayne Pineland, and Fuchs Hammock Addition (20 ha (51 ac)); County/local lands including Camp Owaissa Bauer, Pine Island Lake Park, Seminole Wayside Park, and Northrop Pineland (63 ha (156 ac)); and parcels in private ownership (44 ha (109 ac)), including the private conservation area, Pine Ridge Sanctuary. This unit is bordered on the north by SW 248 Street, on the south by SW 312 Street, on the east by SW 112 Avenue, and on the west by SW 217 Avenue.

Unit LCC7: Navy Wells Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit LCC7 consists of approximately 201 ha (497 ac) of habitat in MiamiDade County. Within Unit LCC7, there are seven subunits (LCC7A–LCC7G), including one larger area (Navy Wells Pineland Preserve) and six smaller outlying areas. The unit is comprised of State lands within Palm Drive Pineland, Navy Wells Pineland #39, Navy Wells Pineland Preserve (portion), and Florida City Pineland (53 ha (132 ac)); County/ local lands including primarily Sunny Palms Pineland and Navy Wells Pineland Preserve (portion) (125 ha (309 ac)); and parcels in private ownership (23 ha (56 ac)). This unit is bordered on the north by SW 320 Street, on the south by SW 368 Street, on the east by U.S. 1 (South Dixie Highway), and on the west by SW 217 Avenue.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Linum carteri carteri critical habitat consists of three components (80 FR 49846-49886):

(i) Areas of pine rockland habitat that contain: (A) Open canopy, semi-open subcanopy, and understory; (B) Substrate of oolitic limestone rock; and (C) A plant community of predominately native vegetation that may include, but is not limited to: (1) Canopy vegetation dominated by Pinus elliottii var. densa (South Florida slash pine); (2) Subcanopy vegetation that may include, but is not limited to, Serenoa repens (saw palmetto), Sabal palmetto (cabbage palm), Coccothrinax argentata (silver palm), Myrica cerifera (wax myrtle), Myrsine floridana (myrsine), Metopium toxiferum (poisonwood), Byrsonima lucida (locustberry), Tetrazygia bicolor (tetrazygia), Guettarda scabra (rough velvetseed), Ardisia escallonioides (marlberry), Psidium longipes (mangroveberry), Sideroxylon salicifolium (willow bustic), and Rhus copallinum (winged sumac); (3) Short-statured shrubs that may include, but are not limited to, Quercus pumila (running oak), Randia aculeata (white indigoberry), Crossopetalum ilicifolium (Christmas berry), Morinda royoc (redgal), and Chiococca alba (snowberry); and (4) Understory vegetation that may include, but is not limited to: Andropogon spp.; Schizachyrium gracile, S. rhizomatum, and S. sanguineum (bluestems); Aristida purpurascens (arrowfeather threeawn); Sorghastrum secundum (lopsided Indiangrass); Muhlenbergia capillaris (hairawn muhly); Rhynchospora floridensis (Florida white-top sedge); Tragia saxicola (pineland noseburn); Echites umbellata (devil's potato); Croton linearis (pineland croton); Chamaesyce spp. (sandmats); Chamaecrista deeringiania (partridge pea); Zamia integrifolia (coontie); and Anemia adiantifolia (maidenhair pineland fern).

(ii) A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat described in paragraph (2)(i) of this entry.

(iii) Habitats that are connected and of sufficient area to sustain viable populations of Linum carteri var. carteri in the pine rockland habitat described in paragraph (2)(i) of this entry.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of Linum carteri var. carteri may require special management considerations or protection to reduce threats related to habitat loss, fragmentation, and modification primarily due to development; inadequate fire management; nonnative, invasive plants; and sea level rise. Destruction of the pinelands for economic development has reduced pine rockland habitat on the Miami Rock Ridge outside of ENP by over 98 percent, and remaining habitat in this area is highly fragmented. Linum carteri var. carteri occurs on a mix of private and publicly owned lands, only some of which are managed for conservation. Populations of the plants that occur on private land or non-conservation public land are vulnerable to habitat loss, while populations on conservation lands are vulnerable to the effects of habitat degradation if natural disturbance regimes are disrupted (e.g., through inadequate fire management). Prolonged lack of fire in pine rockland typically results in succession to rockland hammock, and displacement of native species by invasive, nonnative plants often occurs. Further development and degradation of pine rocklands increase fragmentation and decrease the conservation value of the remaining functioning pine rockland habitat. In addition, pine rocklands are expected to be further degraded and fragmented due to anticipated sea level rise, which would fully or partially inundate some pine rocklands along the coast and in the southern portion of Miami-Dade County (near Navy Wells Pineland Preserve), and cause increases in the salinity of the water table and soils resulting in vegetation shifts in additional pine rocklands across the Miami Rock Ridge. Many existing pine rockland fragments are also projected to be developed for housing as the human population grows and adjusts to changing sea levels. Special management considerations and protections that will address these threats include increased coordination and conservation of these plants and their habitat on

Federal lands, and improved habitat restoration and management efforts (including fire management and nonnative plant treatments) of high-priority and high-elevation sites. (USFWS, 2013)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2013)

**Lifespan**

Adult: 1 - 2 years (USFWS, 2013)

**Breeding Season**

Adult: Flowers year-round (USFWS, 2013)

**Key Resources Needed for Breeding**

Adult: May be pollinated by Insects (USFWS, 2013)

**Reproduction Narrative**

Adult: The reproductive ecology and biology of Linum carteri var. carteri is not well understood, but reproduction is sexual. This species is capable of flowering throughout the year, but tends to have most abundant flowering and fruiting following rain. While specific pollinators are unknown, flower morphology suggests this variety may be pollinated by butterflies, bees, or both; self-pollination has also been suggested. For adult reproductive plants, average plant growth was fairly constant from July through October, flowering and fruit production were most abundant in July, and plant mortality increased during the fall months (USFWS, 2013).

**Habitat Type**

Adult: Terrestrial (USFWS, 2013)

**Habitat Vegetation or Surface Water Classification**

Adult: Pine rocklands that have undergone some sort of substrate disturbance (USFWS, 2013)

**Dependencies on Specific Environmental Elements**

Adult: Disturbed areas (e.g. firebreaks, canal banks, edges of railway beds) (USFWS, 2013)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevations of approximately 1.6–4.8 m (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2013)

**Habitat Narrative**

Adult: Linum carteri var. carteri habitat are areas of pine rockland habitat that contain open canopy, semi-open subcanopy, and understory, a substrate of oolitic limestone rock, and a plant community of predominately native vegetation. A disturbance regime is also present that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat (USFWS, 2014). Its known populations are found at elevations ranging from approximately 1.6–4.8 m (5.2 - 15.9 ft) (USFWS, 2013).

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Unknown (USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: Dispersers are unknown, although historically water may have played a role in dispersal when summer high- water conditions in adjacent wet prairies may have inundated portions of pine rocklands (USFWS, 2013).

***Population Information and Trends***

**Population Trends:**

Not available.

**Species Trends:**

Declining (USFWS, 2014)

**Population Growth Rate:**

Low (inferred from USFWS, 2014)

**Number of Populations:**

6 (USFWS, 2023)

**Population Size:**

~2000 individuals (USFWS, 2023)

**Population Narrative:**

Only small and fragmented occurrences of L. c. var. carteri remain. Four of the seven remaining populations have fewer than 20 individual plants. There are great differences in plant numbers from year to year, probably because individuals typically live 1–2 years and grow from seed. This trait makes them more vulnerable than perennials to changes in environment. Viable plant populations for small, short-lived herbs may consist of tens of thousands of plants. Indications are that most existing populations are at best marginal (USFWS, 2014). Carter’s small-flowered flax is currently known from six occurrences in Miami-Dade County (Table 1). The total number of individual plants during peak months (spring/summer) is approximately 2000 (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat loss, fragmentation, and degradation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Habitat modification caused by development (i.e., conversion to both urban and agricultural land uses) is a primary threat, in addition to habitat modification and degradation through inadequate fire management, which includes both the lack of prescribed fire and suppression of natural fires. Habitat fragmentation reduces the size of plant populations, and increases spatial isolation of remnants (USFWS, 2013)

**Stressor:** Competition from nonnative invasive plants (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of Linum carteri var. carteri to some degree. Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which responds positively to open conditions; the invasive plants also affect the characteristics of a fire when it does occur (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Extreme weather events could be catastrophic on isolated, small populations. The narrow distribution makes them more susceptible to extirpation from a single catastrophic event (USFWS, 2013).

**Stressor:** Incompatible management practices (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Incompatible management practices (such as no mowing or too-frequent mowing), fire suppression, accidental impacts to populations that grow along preserve edges, illegal dumping, invasive non-native plants, factors stemming from small population sizes, and climate change (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Not available.

Recovery Priority Number: 6

**Delisting Criteria:**
Not available.

**Recovery Actions:**
- Not available.
- Not available

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES In additional to standard monitoring and assessment of the species' status, the highest priority actions recommended for Carter's small-flowered flax are: • Conduct or continue to conduct habitat restoration on all occupied sites, including (a) removal of native hardwoods and non-native invasive plants and (b) establish a prescribed burn regimen. • Acquire and restore habitat at Old Dixie Pineland. • Restore habitat at the Montgomery Botanical Center pineland and the Gifford Arboretum pineland sites. Monitor whether plants emerge from the soil seed bank, and if so, develop a long-term management plan for the sites. • Convert the portion of the USDA Chapman Field Station where the species is found into a managed nature preserve. • Work with land managers to incorporate conservation mowing regimes beneficial to the species • Ensure that populations which are maintained through mowing are not mowed between January and July but are mowed between August and December. • Bank seeds from wild populations, with a focus on those whose seeds were last banked over a decade ago. Additional recommended actions are: • Conduct studies to determine whether Manila grass has negative effects on the species' reproduction or growth. • Conduct additional studies (following Maschinski and Walters 2008) to determine optimal mowing regimes. • Fine-tune horticultural methods for ex situ cultivation. • Research the pollination biology of the species. • Conduct genetic research to determine the amount of genetic variation between and within populations. • Introduce additional metapopulations to suitable habitat at the Deering Estate. • Introduce plants to suitable habitat at Camp Owaissa Bauer. • Determine whether there is potential for additional reintroductions or augmentations (USFWS, 2023).

**References**

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016

USFWS. 2013. Proposed Endangered Status for Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax)

Proposed Rule. 78 FR 61273 - 61293 (October 3, 2013). USFWS. 2015. Designation of Critical Habitat for Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax)

Final Rule. 80 FR 49846 - 49886 (August 17, 2015).

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# SPECIES ACCOUNT: *Lomatium cookii* (Cook's lomatium)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/9/2002; Pacific Region (R1)

**Physical Description**

A perennial herb that grows 15 to 50 centimeters (6 to 20 inches) tall with a slender, twisted taproot (Figure II-3). The base often branches at or below ground level, forming multiple stems. The leaves are glossy bluish-green, minutely interdivided, and strictly basal (growing directly from the root crown, out of the ground, not along the stems). The pale yellow flowers are clustered into 5- centimeter (2-inch) umbels (umbrella-like formation of flower clusters). Each flowering stalk produces either primarily male or female umbels. Through one flowering season, L. cookii may produce up to eight male or female (sometimes both) flowering stalks. The bracts found below the umbels are thin, lance-shaped and have an entire margin. An umbel of female flowers will develop boat-shaped fruits 8 to 13 millimeters (0.3 to 0.5 inch) long with thickened margins. The flowering stalk very rarely forms leaves, unlike the closely associated L. utriculatum (foothills desert parsley). The single umbel bracts best distinguish L. cookii from L. bradshawii (Bradshaw's lomatium), indigenous to wet prairies from the southern Willamette Valley in Oregon to southwest Washington, and L. humile (alkali desert parsley), found in vernal pools in northern California (Kagan 1986). The umbel bracts can be used to distinguish L. cookii from the much wider, toothed, and overlapping umbel bracts of L. utriculatum. (USFWS, 2010)

**Taxonomy**

In the parsley family (Apiaceae). Lomatium cookii was first collected in 1981 and subsequently described from vernal pools in the Agate Desert, Jackson County, Oregon (Kagan 1986). Additional populations were found at French Flat in the Illinois Valley, Josephine County, Oregon in 1988 (Oregon Natural Heritage Information Center 2008). Slight morphological differences exist between L. cookii populations in the Agate Desert and French Flat, but these differences are not considered significant enough to separate the species into subspecies (M. Gitzendanner, pers. comm. 2002). (USFWS, 2010)

**Historical Range**

In southwestern Oregon, in Jackson and Josephine Counties. (USFWS, 2010)

**Current Range**

In Oregon, known from the Agate Desert, just north of the City of Medford in Jackson County's Rogue Valley, and from the French Flat or Illinois Valley sites in Josephine County. (USFWS, 2019)

**Critical Habitat Designated**

Yes; 8/20/2010.

**Legal Description**

On July 21, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective August 20, 2010) for Lomatium cookii (Cook's lomatium) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes sixteen critical habitat units (CHUs), in Oregon (75 FR 42490-42570).

**Critical Habitat Designation**

The critical habitat designation for Lomatium cookii includes sixteen CHUs in Jackson and Josephine Counties, Oregon. This species critical habitat encompasses approximately 6,289 acres (ac) (2,545 hectares (ha)) (75 FR 42490-42570). All critical habitat units in Jackson County are located within the Middle Rogue River Basin or “Agate Desert.” Brief descriptions are presented below. Detailed coordinates of and maps depicting the CH units are available in the Final Rule (USFWS, 2010).

Unit RV6, subunits A, F, G, and H, for Lomatium cookii: White City, Jackson County, Oregon. (i) Unit RV6, subunits A, F, G, and H for Lomatium cookii comprises 546 ha (1,349 ac) of vernal pool–mounded prairie and swale habitats. RV6 is located around White City, is 1.6 km (1.0 mi) southwest of Eagle Point, and is 440 m (1,444 ft) southeast of the confluence of the Rogue River and Little Butte Creek. Subunit RV6A is located north of Whetstone Creek and is 500 m (1,200 ft) west of the junction of Highway 62 and Antelope Road. Subunits RV6F and RV6G are located approximately 500 feet west of Dry Creek and are east of Highway 62 in White City. Subunit RV6H is located north of Whetstone Creek and south of Antelope Road. Subunit RV6H roughly encircles the Hoover Ponds, east of Highway 62, and is 850 m (2790 ft) east of subunit RV6A.

Unit RV8 for Lomatium cookii: Whetstone Creek, Jackson County, Oregon. (i) Unit RV8 for Lomatium cookii consists of 344 ha (850 ac) of vernal pool–mounded prairie and swale habitat. Unit RV8 is located approximately 1.4 km (0.9 mi) southeast of the confluence of the Rogue River and Whetstone Creek, 2.2 km (1.4 mi) southwest of Tou Velle State Park, and 2.9 km southeast of the confluence of Bear Creek and the Rogue River. The unit roughly parallels a 2.6-km (1.6-mi) stretch of Whetstone Creek to the south.

Unit RV9, subunits A, B, C, D and E, for Lomatium cookii: Medford Airport, Jackson County, Oregon. (i) Unit RV9, subunits A through E, consists of 34 ha (83 ac) of slightly degraded vernal pool–mounded prairie habitat. The five subunits of RV9 are located mostly within the Rogue Valley International–Medford Airport, approximately 2 km (1.2 mi) west of Coker Butte and 1.5 km (0.9 mi) northeast of Bear Creek. Subunit RV9A is located 1.4 km (0.9 mi) north of the Rogue Valley International–Medford Airport and is 300 m (980 ft) east of the junction of Vilas Road and Table Rock Road. Subunits RV9B through E are located between Upton Slough and Bear Creek, 2 mi (1.2 km) southeast of the junction of Vilas Road and Table Rock Road, and 1.7 km northeast of the junction of Interstate 5 and Highway 62.

Unit IV1 for Lomatium cookii: Anderson Creek, Josephine County, Oregon. (i) Units IV1A and B comprise 35 ha (85 ac) of wet meadow and sloped mixed conifer habitat. Unit IV1A is located 3.5 km (2.2 mi) north of Selma, and 14 km (8.8 mi) north of Cave Junction; it is along a 1.0-km (0.6-mi) stretch of Anderson Creek and Highway 199, 2.0 km (1.2 mi) southwest of Hays Hill Summit. It is also 1.7 km (1.0 mi) northwest of the junction of Draper Valley Road and Indian Creek Road. Unit IV1B is located 3.5 km (2.2 mi) north of Selma, 3.4 km (2.1 mi) southwest of Hays Hill Summit, and 0.8 km (0.5 mi) west of the junction of Draper Valley Road and Highway 199.

Unit IV2 for Lomatium cookii: Draper Creek, Josephine County, Oregon. (i) Unit IV2 is composed of 28 ha (70 ac) of intact wet meadow habitat. It is located 2.7 km (1.7 mi) northeast of Selma and 13.5 km (8.4 mi) north of Cave Junction; it is along a 900-m (2,900-ft) stretch of Draper Creek, and is located 800 m (2,600 ft) east of Anderson Creek. The unit is 800 m (2,600 ft) north-

northwest of the confluence of Draper Creek and Davis Creek and is 200 m (650 ft) southeast of the junction of Draper Valley Road and Indian Creek Road.

Unit IV3 for Lomatium cookii: Reeves Creek North, Josephine County, Oregon. (i) Unit IV3 consists of 152 ha (374 ac) of sloped, mixed-conifer and shrubby habitat. The unit is located 1.4 km (0.9 mi) east of the confluence between Reeves Creek and the Illinois River and extends along a 2.0-km (1.2-mi) stretch of Reeves Creek, beginning 800 m (2,600 ft) northeast of the junction of Highway 199 and Reeves Creek Road.

Unit IV4 for Lomatium cookii: Reeves Creek East, Josephine County, Oregon. (i) Unit IV4 consists of 83 ha (204 ac) of sloped, partially open, mixed-conifer and shrubby habitat. It is located 6.2 km (3.9 mi) south of Selma and 5.3 km (3.3 mi) northwest of Cave Junction. It occurs along a 500-m (1,640-ft) stretch of Reeves Creek located 700 m (2,300 ft) southeast of Unit IV3.

Unit IV5 for Lomatium cookii: Reeves Creek South, Josephine County, Oregon. (i) Unit IV5 consists of 165 ha (407 ac) of sloped, partially open, mixed-conifer and understory shrub habitat. The unit is roughly parallel to Highway 199 for 2.5 km (1.6 mi), which is 500 m (1,640 ft) west of the unit. The unit is located 1.6 km (1.0 mi) north of Cave Junction, 1 km (0.6 mi) southeast of Sauers Flat, 800 m (2,600 ft) east of Kerby, and 1.2 km (0.7 mi) east of the confluence between Holton Creek and the Illinois River.

Unit IV6 for Lomatium cookii: Laurel Road, Josephine County, Oregon. (i) Unit IV6 totals 182 ha (449 ac) of intact wet meadow habitat. It is located west and alongside of the base of Lime Rock, 1.2 km (0.7 mi) east of the city of Cave Junction; it follows along Highway 46 for 1.5 km (0.9 mi). Subunit IV6A is located 1.2 km (0.7 mi) west of Lime Rock summit, 1.0 km east of the junction of Laurel Road and Highway 199; it is also roughly parallel to Highway 199 for 1.3 km (0.8 mi). Highway 199 lies approximately 1.0 km (0.6 mi) west of the subunit. Subunit IV6B is 2.7 km (1.7 mi) east of the confluence of the east and west forks of the Illinois River and from the intersection of Holland Loop Road and Highway 46; it extends approximately 1.8 km (1.1 mi) to the northeast and 2.7 km (1.7 mi) to the north.

Unit IV7 for Lomatium cookii: Illinois River Forks State Park, Josephine County, Oregon. (i) Unit IV7 consists of 55 ha (136 ac) of intact wet meadow habitat. The unit is located 500 m (1,640 ft) west of the city of Cave Junction and 600 m (1,970 ft) southeast of Pomeroy Dam; it is also 230 m (750 ft) east of the confluence of the east and west forks of the Illinois River. The unit occurs along a 2.8-km (1.7-mi) stretch of the West Fork Illinois River.

Unit IV8 for Lomatium cookii: Woodcock Mountain, Josephine County, Oregon. (i) Unit IV8 consists of 234 ha (579 ac) of wet meadow and shrubby habitat. The unit is located 2.4 km (1.5 mi) southwest of the city of Cave Junction, 5.3 km (3.3 mi) north of O’Brien, and 140 m (ft) west of the confluence of Woodcock Creek and the West Fork Illinois River. It occurs along a 3.3-km (2.0-mi) stretch of West Side Road. Unit IV7 is 400 m (ft) west of Highway 199 and roughly parallels the highway for 5.0 km (3.1 mi).

Unit IV9 for Lomatium cookii: Riverwash, Josephine County, Oregon. (i) Unit IV9 consists of 12 ha (30 ac) of intact wet meadow and streambank habitat. It is located 4.2 km (2.6 mi) south of Cave Junction and 6.1 km (3.8 mi) north-northeast of O’Brien. It is located along the east bend of the West Fork Illinois River, 700 m (2,300 ft) south (upstream) of the confluence between Woodcock

Creek and the West Fork Illinois River.

Unit IV10 for Lomatium cookii: French Flat North, Josephine County, Oregon. (i) Unit IV10 consists of 45 ha (110 ac) of intact wet meadow habitat. The unit is located 3.7 km (2.3 mi) south of Cave Junction, 900 m (2,950 ft) north of the intersection of Sherrier Drive and Raintree Drive, and 1.7 km (1.1 mi) southwest of the confluence of Althouse Creek and the East Fork Illinois River. It parallels a 300-m (980-ft) stretch of Rockydale Road.

Unit IV11 for Lomatium cookii: Rough and Ready Creek, Josephine County, Oregon. (i) Unit IV11 consists of 118 ha (292 ac) of intact wet meadow habitat. The unit roughly follows along and is adjacent to a 1.9-km (1.2-mi) stretch of Airport Drive. It is located 3 km (1.9 mi) north of O'Brien, 900 m (2,950 ft) west of the Rough and Ready Forest Wayside State Park, and 122 m (400 ft) east of the confluence with the Illinois River and Rough and Ready Creek.

Unit IV12 for Lomatium cookii: French Flat Middle, Josephine County, Oregon. (i) Unit IV12 consists of 492 ha (1,216 ac) of intact wet meadow habitat. The unit is located 4.5 km (2.8 mi) east of Cave Junction, 3.7 km (2.3 mi) northeast of O'Brien, 140 m (460 ft) north and 560 m (1,830 ft) west of Esterly Lakes, 1.4 km (0.9 mi) northeast of Indian Hill, and 300 m (960 ft) east of the confluence of Rough and Ready Creek and the West Fork Illinois River. It also follows along a 1.6-km (1.0-mi) stretch of Rockydale Road until the junction with Waldo Road.

Unit IV13 for Lomatium cookii: Indian Hill, Josephine County, Oregon. (i) Unit IV13 consists of 22 ha (54 ac) of intact wet meadow habitat. The unit is located adjacent to and lies east of a 900-m (2,950-ft) stretch of the West Fork Illinois River. It is located approximately 300 m south (upstream) of the confluence of Rough and Ready Creek and the West Fork Illinois River. The unit is 1.8 km (1.1 mi) northeast of O'Brien and 350 m (1,150 ft) northwest of Indian Hill.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lomatium cookii critical habitat consists of the following components (75 FR 42490-42570): (USFWS, 2010)

(i) In the Rogue River Valley: (A) Vernal pools and ephemeral wetlands and depths and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain Lomatium cookii germination, growth, and reproduction. These vernal pools or ephemeral wetlands support native plant populations and are seasonally inundated during wet years but do not necessarily fill with water every year due to natural variability in rainfall. Areas of sufficient size and quality are likely to have the following characteristics: (1) Elevations from 372 to 411 m (1,220 to 1,350 ft); (2) Associated dominant native plants including, but not limited to: Alopecurus saccatus, Achnatherum lemmonii, Deschampsia danthonioides, Eryngium petiolatum, Lasthenia californica, Myosurus minimus, Navarretia leucocephala ssp. leucocephala, Phlox gracilis, Plagiobothrys bracteatus, Trifolium depauperatum, and Triteleia hyacinthina; and (3) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(B) The hydrologically and ecologically functional system of interconnected pools or ephemeral wetlands or depressions within a matrix of surrounding uplands that together form vernal pool complexes within the greater watershed. The associated features may include the pool basin and ephemeral wetlands; an intact hardpan subsoil underlying the surface soils up to 0.75 m (2.5 ft) in depth; and surrounding uplands, including mound topography and other geographic and edaphic features that support systems of hydrologically interconnected pools and other ephemeral wetlands (which may vary in extent depending on sitespecific characteristics of pool size and depth, soil type, and hardpan depth).

(C) Silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 3 percent slope, classified as Agate–Winlo or Provig– Agate soils.

(D) No or negligible presence of competitive, nonnative invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow Lomatium cookii to continue to survive and recover.
(ii) In the Illinois River Valley: (A) Wet meadows in oak and pine forests, sloped mixed-conifer openings, and shrubby plant communities that are seasonally inundated and support native plant populations. Areas of sufficient size and quality are likely to have the following characteristics: (1) Elevations from 383 to 488 m (1,256 to 1,600 ft); (2) Associated dominant native plants including, but not limited to: Achnatherum lemmonii, Arbutus menziesii, Arctostaphylos viscida, Camassia spp., Ceanothus cuneatus, Danthonia californica, Deschampsia cespitosa, Festuca roemeri var. klamathensis, Poa secunda, Ranunculus occidentalis, and Limnanthes gracilis var. gracilis; (3) Occurrence primarily in bottomland Quercus garryana–Quercus kelloggii–Pinus ponderosa (Oregon white oak–California black oak– ponderosa pine) forest openings along seasonal creeks; and (4) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(B) The hydrologically and ecologically functional system of streams, slopes, and wooded systems that surround and maintain seasonally wet alluvial meadows underlain by relatively undisturbed ultramafic soils within the greater watershed.

(C) Silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 40 percent slope, classified as Abegg gravelly loam, Brockman clay loam, Copsey clay, Cornutt–Dubakel complex, Dumps, Eightlar extremely stony clay, Evans loam, Foehlin gravelly loam, Josephine gravelly loam, Kerby loam, Newberg fine sandy loam, Pearsoll–Rock outcrop complex, Pollard loam, Riverwash, Speaker–Josephine gravelly loam, Takilma cobbly loam, or Takilma Variant extremely cobbly loam.

(D) No or negligible presence of competitive, nonnative invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow Lomatium cookii to continue to survive and recover.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and that may require special management considerations or protection. All areas we are designating as critical habitat require some level of management to address current and future threats to Lomatium cookii, to maintain or enhance the physical or biological features essential to their conservation, and to ensure the recovery and survival of these species. The major threats to the PCEs in the areas identified as critical habitat for Lomatium cookii include: development on private lands; mining activities; ground disturbance that affects surface hydrology, including ORV use and road construction or maintenance activities; incompatible agricultural and grazing practices; garbage dumping; the succession of meadow habitat to forested habitat due to fire suppression; and encroachment and displacement by nonnative plants. Herbivory by voles may also affect Lomatium cookii in the Illinois River Valley. In all of the units in Jackson County, special management is needed to reduce or eradicate the threats posed by development, habitat fragmentation, ground disturbance that affects surface hydrology, and incompatible grazing practices. In all of the units in Josephine County, special management is needed to reduce or eradicate the threats posed by development, ORV use, mining activities, garbage dumping, and woody vegetative succession. Please refer to the unit descriptions in the Critical Habitat Designation section for further discussion of special management considerations or protection of the PCEs related to geographically specific threats to Limnanthes floccosa ssp. grandiflora and Lomatium cookii. In addition, for all units, special management is needed to control and monitor the encroachment of nonnative, invasive plant species to maintain intact vernal pool–mounded prairies and wet meadow ecosystems such that they can continue to support populations of Lomatium cookii. Special management considerations or protection of the vernal pool– mounded prairies and wet meadow habitats that may be needed to support reproduction and growth of Lomatium cookii include: controlled burning and vegetation clearing to maintain early seral stages (early stages of plant succession in the progression toward a climax community); control of nonnative, invasive plant species; grazing management; the reestablishment of hydrology; re-seeding with native plants; monitoring; and protection from development (Borgias 2004, pp. 47–53; ONHDB 1994, pp. 13– 20). (USFWS, 2010)

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Seasonally wet (vernal soil) (USFWS, 2016)

**Environmental Specificity**

Adult: Very Narrow (USFWS, 2016)

**Habitat Narrative**

Adult: Desert parsley in the Illinois Valley grows on seasonally wet soils. For much of its range in the Rogue River Valley, the plant occurs on upland mounds, at the bottom of rocky vernal pools, and on vernal pools flanks. It occurs in either strongly expressed or weakly expressed vernal pool formations and appears to tolerate various types of disturbance. In the Rogue River Valley, populations of desert parsley are found in shallow Agate-Winlo complex in sparse prairie vegetation. Common plant associates include Lupinus bicolor (bicolor lupine), Colinsia sparsiflora (sparse-flowered collinsia), Clarkia purpurea (purple clarkia), Erodium cicutarium (filaree), foothills desert-parsely, Achnatherum lemmonii (Lemmon’s needlegrass), Poa bulbosa (bulbous bluegrass), Brodiaea elegans (elegant brodiaea), Madia spp (tarweed), Lasthenia californica (goldfields), Hemizonia fitchii (Fitch’s tarweed), and Plagiobothrys spp (popcornflower). In the Illinois Valley, desert parsley occurs in open wet meadows and along roadsides adjacent to meadows on Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam soils. Brockman clay loam soils in the French Flat area average 61 to 89 cm (24 to 35 inches) in depth.

These seasonally wet soils have the ability to block water permeability through the soil, similar to the Agate Desert vernal pools, but lack that region's distinctive mound and swale topography. Soils in the Illinois Valley are partially derived from serpentine formations that occur on surrounding slopes and hilltops. Common species in the Illinois Valley associated with desert parsley include Danthonia californica (California oatgrass), Chlorogalum pomeridianum (soap plant), Plagiobothrys bracteatus (bracted popcornflower), Hesperichiron californica (hesperichiron), Horkelia californica (California horkelia), Calochortus uniflorus (short-stemmed mariposa lily), and wedge-leaved buckbrush. Two rare plants that may occasionally occur with desert parsley in the Illinois Valley are Senecio hesparius (western senecio) and Microseris howellii (Howell's microseris) (USFWS, 2016).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019)

**Number of Populations:**

23 extant (USFWS, 2024)

**Population Size:**

10,000 - 1,000,000 individuals (NatureServe, 2024)

**Additional Population-level Information:**

Based on representative population assessments at the monitored locations provided in the 2019 5-Year Review, as well as assuming the other known populations are still occupied by Lomatium cookii, we conclude the overall distribution remains unchanged. Lomatium cookii remains concentrated within the Illinois and Rogue River Valleys of southwestern Oregon and within its known historical range. Even with the extirpation of one population and the addition of one populations, range contraction or expansion of the species has not occurred. (USFWS, 2019)

**Population Narrative:**

There are a total of 36 populations of Lomatium cookii, 11 in the Rogue Valley and 25 in the Illinois Valley. Here we present the most recent information available through the individual monitoring programs for most of the 36 sites that have been assessed since the last census. This includes information for one new population record of Lomatium cookii (Waldo Road in the Illinois Valley). Information is not available for 15 known occurrences of the species (Table 1). It should be noted that L. cookii population parameters fluctuate annually depending on seasonal precipitation and temperature; therefore, it is not unexpected that the species population size estimate will vary from year to year. (USFWS, 2019). Geographically, the overall population is distributed into two areas, the Rogue and Illinois Valleys. In the Rogue Valley, the 14 known Cook's lomatium populations consist of 7 recently monitored (or extant) and 7 unknown populations (Table 1 and Figure 1). Of the 7 known populations, abundance in 6 populations is increasing or stable and 1 is in decline. In the Illinois Valley we have documented 16 extant populations and 6 unknown populations (Table 2 and Figure 2). Of the 16 extant populations, abundance in 11 populations is increasing or stable and 5 are in decline. Overall, both areas combined, a total of 23 populations are documented as extant and 13 are considered unknown (ORBIC 2023, entire; ODA 2021, p. 6, USFWS 2024, entire). Unknown populations have had no documentation in the last 10 years, mostly due to inaccessibility. An additional 5 population have been determined to be extirpated. The previous 5-year review in 2019, documented a total of 10 Rogue Valley and 25 Illinois Valley populations. Of these, 20 were documented as extant and 15 were considered unknown (USFWS 2019a). At that time, we only knew of a single extirpated population (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat or population loss due to development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Factor A listing threats include habitat or population loss due to development, either through present or threatened destruction, modification or curtailment of habitat or range (USFWS 2002). Factor A threats to Lomatium cookii in the Rogue and Illinois River valleys include habitat impacts resulting from residential, urban, and commercial development; aggregate and mineral mining; agricultural development (including leveling, ditching, tilling, and stock pond construction or water impoundments); road construction and maintenance; off-road vehicle (ORV) use that affects surface hydrology; incompatible grazing practices; and encroachment by nonnative plants (ONHDB 1994; USFWS 2002). The adverse effects of residential, urban, and commercial development are more evident in the Rogue River Valley while the threat of mining is a more conspicuous threat in the Illinois River Valley (USFWS 2002; USFWS 2010). Factor A impacts resulting from residential, urban, agricultural, industrial, and commercial development between 1940 to present, resulted in over 60 percent loss of the vernal pool landscape in the Rogue River Valley due to removal of habitat, altered hydrology, or altered topography (ONHP 1997; Wille and Petersen 2006). (USFWS, 2011)

**Stressor:** Vandalism (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Vandalism are Factor A threats in the form of intentional disregard or dismantling of signage or fencing intended to protect certain wetland areas from unauthorized ORV use, and subsequent damage resulting from that use, has resulted in negative effects on the hydrology of the habitat for Lomatium cookii (for example, by altering the surface hydrology, resulting in excess or a lack of hydrology in otherwise suitable habitat). (USFWS, 2011)

**Stressor:** Grazing (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The effect of grazing on suitable habitat depends on how the grazing is managed. There are various reports showing how grazing practices can positively or negatively affect native plant species’ richness (Marty 2005). Marty’s (2005) study indicates that wet season grazing resulted in a decrease of native forb species at vernal pool edge habitat, but year-round grazing actually improved species’ richness (Factor A listing threats). (USFWS, 2011)

**Stressor:** Non-native plants and small population size (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Lomatium cookii is also threatened by encroachment of nonnative plants and small population size (Factor E listing threats). Nonnative plants that can outcompete L. cookii include annual grasses and herbs. Nonnative grasses, namely Hordeum marinum ssp. gussoneanum (Mediterranean barley), Lolium spp. (perennial and annual rye), and Taeniantherum caput-medusae (medusahead), form a dense thatch layer that inhibits plant growth (USFWS 2010). (USFWS, 2011)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Depending on whether intentions were deliberate or inadvertent, Factor D, the lack of legal protection for all federally or state listed plants on privately owned property could be partially responsible for much habitat loss in recent years due to development in areas that were incorrectly assumed to be outside of jurisdictional wetlands (USFWS 2006). (USFWS, 2011)

**Stressor:** Herbicide spraying, mowing, grading, and other road maintenance activities (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbicide spraying, mowing, grading, and other road maintenance activities may threaten small Cook's lomatium sites adjacent to roads on private lands in the range of the species. However, this threat is unknown but considered relatively insignificant because the species is not prevalent on roadsides. ODOT carefully maintains their roadside shoulders where Cook's lomatium occurs without herbicide and is able to maintain populations (USFWS, 2024).

**Stressor:** Illicit recreational cannabis (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Illicit recreational cannabis (Cannabis sativa) production has had a long history in Josephine County (Parker-Shames et al. 2021, p. 2). Until 2015, when Oregon enacted legislation to legalize growing, purchasing, using, and transporting cannabis, illicit production primarily occurred on public lands. The legalization of recreational cannabis has resulted in an increase in recreational cannabis crop production on private lands across southwest Oregon (Parker-Shames et al. 2021, p. 2). Cave Junction has been a center for illegal cannabis production for many years and this trend is likely to continue (Willamette Week 2023, website). The expansion of cannabis growing has converted at least one known population of Cook's lomatium into a cannabis crop (ODA 2021, p. 32). The crop was established within a larger Cook's lomatium population near West Side Road. Although some of these private lands are not easily accessed, agricultural crops will appear on aerial imagery, and we will infer that a population has been compromised if replaced by a crop. The majority, 67 percent, of Cook's lomatium populations occur on public

lands. Private lands include 32 percent of populations (13 of 41). For this reason, it is uncertain if cannabis crops will become an increased threat for Cook's lomatium in the future on either public or private lands (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
Reclassification from Endangered to Threatened status may be considered for Lomatium cookii when the following criteria are met: (USFWS, 2010)

a. At least 32 of 36 documented/extant Lomatium cookii occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

b. At least 90 percent of suitable habitat acreage within each Priority 1 core area (one core area in the Rogue Valley and seven core areas in the Illinois Valley) has been protected from development. At least 85 percent of suitable habitat acreage within Priority 2 core areas (three core areas in the Rogue Valley and six core areas in the Illinois Valley) has been protected from development. (See Tables IV-1, IV-2, and IV-4 of the Recovery Plan). All suitable vernal pool and wet meadow habitat must include soils and hydrology that support Lomatium cookii. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations. (USFWS, 2010)

c. Management plans for each protected core area are developed and implemented as soon as feasible for Lomatium cookii protection and conservation. The management plans should address vegetation control, including thatch buildup and noxious weeds; monitoring of threats and population levels in detail sufficient to quantitatively assess population trends; maintaining hydrological functions; and outreach to neighboring landowners. Management plans should take an ecosystem approach to management by ensuring the long-term maintenance of wetland and adjacent upland plant associates. (USFWS, 2010)

d. Additional Lomatium cookii occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. (USFWS, 2010)

e. Achievement of self-sustaining Lomatium cookii populations will be determined through species monitoring and status surveys in each protected occurrence. Population trends must be shown to be stable, increasing or showing only minor declines from high population levels for 10 years prior to consideration for reclassification. (USFWS, 2010)

f. Seed collection is accomplished at each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4 of the Recovery Plan). (USFWS, 2010)

g. Reintroductions and introductions must be carried out as described in Table IV-4 of the Recovery Plan. Introductions may replace extirpated occurrences that cannot be restored to the same site as the original occurrence. (USFWS, 2010)

Recovery Priority Number: 2C

**Delisting Criteria:**
Delisting may be considered for Lomatium cookii when all downlisting criteria plus the following criteria are met: (USFWS, 2010)

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (e.g., evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats. (USFWS, 2010)

b. At least 34 of 36 Lomatium cookii occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support Lomatium cookii . Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4). (USFWS, 2010)

d. A post-delisting monitoring plan has been developed for Lomatium cookii. (USFWS, 2010)

**Recovery Actions:**

- 1. Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses. Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery core areas, while lower priority actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions. (USFWS, 2010)

- 2. Manage, monitor, and restore vernal pool and wet meadow habitat. Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation; monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known Lomatium cookiipopulations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species. (USFWS, 2010)
- 3. Conduct rangewide population status surveys. A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site. (USFWS, 2010)
- 4. Conduct research essential to the conservation of these species. In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. Study pollination vectors between and among populations. Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors. Evaluate techniques to reduce impacts from encroachment of native woody plant succession. Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses. Refine research on appropriate grazing practices. Research genetic and morphologic traits among individuals and populations. Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill. Determine incidence of herbivory or predation on Lomatium cookiipopulations. Develop offsite and onsite cultivation and propagation techniques for Limnanthes pumila ssp. grandiflora. Research associated soil crusts as indicators for vernal pool health and function. (USFWS, 2010)
- 5. Enhance public awareness and participation in recovery of the species. Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the species. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans. Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved. Complete post-delisting monitoring plan for Limnanthes pumila ssp. grandiflora. (USFWS, 2010)
- Recommendations for Future Actions: • Develop conservation easements or conservation programs for existing occurrences of Lomatium cookii on private lands. • Make visits to

historical Lomatium cookii occurrences in the Illinois and Rogue Valleys to determine whether the plants are still present or have become extirpated. • Augment Lomatium cookii on protected habitat in appropriate locations in the Illinois and Rogue Valley areas. • Conduct best management practices studies for Lomatium cookii. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- Recommendations for Future Actions: • Cook's lomatium habitat occurs on a mix of public and private lands. Because successful conservation of Cook's lomatium will need to include voluntary contributions from private lands, an enhanced and targeted outreach effort to private landowners is needed for conservation partnerships in key areas leading to protected areas contributing to recovery. • Develop conservation easements or conservation programs for existing populations on unprotected private lands. This would directly increase protection status for Cook's lomatium. We are targeting partnerships for the protection of 10 populations on private lands in the next 5 years. • Determine locations to establish Cook's lomatium in the Illinois and Rogue Valleys. If a population is declining, we recommend careful and strategic augmentation. If plants are not present, we recommend sowing seed to reestablish plants as appropriate for the conditions. • Conduct research on the best management practices for Cook's lomatium. For example, high priority research would include best grazing, mowing, herbicide, or fire practices to address seral vegetation succession, encroachment of weedy vegetation and climate change stressors. The best management practices could promote suitable habitat conditions to increase population size and refine plant establishment techniques (USFWS, 2024).

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# SPECIES ACCOUNT: *Lupinus aridorum* (Scrub lupine)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/7/1987; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Woody, perennial herb, with sprawling stems up to 1 m long. The leaves are obovate-elliptic, 4 to 7 cm long and 2 to 4 cm wide. The base and end of the leaf are rounded with a sharp point at the leaf's end. The petioles are 2.0 to 4.5 cm long and the stipules are very small or absent. A silvery pubescence covers the leaves and stems. The flowers are a pale flesh-colored pink and are 4 to 5 cm long. The upper petal (standard) has a black center surrounded by a maroon area. Flowers are arranged in racemes with stalks 4 to 13 cm long. Each raceme has 5 to 14 flowers, but up to 25 on occasion. Fruits are long, woody, and elliptical with a pointed end. It is differentiated from L. villosus, the only other pink flowering lupine, in that L. aridorum is not prostrate, has hairs on the leaves and stem, and is the only upright pink-flowering lupine in Florida. (USFWS, 1999).

**Taxonomy**

Until being named L. aridorum in 1982, this taxon was identified as L. diffusus and L. westianus (52 FR 11172). Isley (1986, 1990) evaluated the systematics of L. aridorum in his floristic treatment of the pea family (Fabaceae) in the Southeast and concluded that L. aridorum belongs to the same species as L. westianus of the Gulf Coast of northwest Florida, which differs mainly in flower color (blue). Isley's taxonomic status for the central Florida plant is L. westianus var. aridorum (McFarlin ex Beckner) Isley. However, the former classification L. aridorum was used to list the species (52 FR 11172), and will be used here to maintain consistency. (USFWS, 1999; USFWS, 2016)

**Historical Range**

Historical range is two areas of central Florida: western Orange and extreme northwestern Osceola counties on the southern Mount Dora Ridge and in north-central Polk County on the Winter Haven Ridge (USFWS, 2007).

**Current Range**

Currently found on two interior ridges in central Florida: Winter Haven Ridge in Polk County and Mount Dora Ridge in Orange and Osceola Counties. (USFWS, 2016)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: Average 2-4 years, up to 6-7 years (USFWS, 2022)

**Breeding Season**

Adult: Flowers in late March-May (USFWS, 1999)

**Reproduction Narrative**

Adult: The scrub lupine has been found in bloom between March and May. The seed pods mature by June, and the seeds fall off the plant and take root nearby or remain in a long-lived seedbank. Recent information indicates the plant may bloom from one to three times throughout its life, though few seeds are produced the first year. Pollinators of this species are unknown (USFWS, 1999). Many perish after the first year, but most survive 2 to 3 years with 1 to 3 reproductive cycles. Plants have been recorded to flower at 6 to 7 years. (USFWS, 2022).

**Habitat Type**

Adult: Terrestrial (USFWS, 1999)

**Habitat Vegetation or Surface Water Classification**

Adult: Sandy openings in sand pine-rosemary-oak scrub (USFWS, 1999)

**Dependencies on Specific Environmental Elements**

Adult: Soils are very dry and have very little organic accumulation, and quite acidic with a pH from 4.0 to 4.5 (USFWS, 1999).

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Habitat is sandy openings in sand pine-rosemary-oak scrub. Soils are very dry and have very little organic accumulation, and quite acidic with a pH from 4.0 to 4.5. The scrub lupine will not grow near rosemary (Ceratiola ericoides) because of rosemary's allelopathic effects. Most of the sites where L. aridorum is now found are moderately to severely disturbed by soil scraping, road construction, land clearing, or off-road vehicles (USFWS, 1999; NatureServe, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Dispersal is not well described (USFWS, 1999).

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2007)

**Species Trends:**

3 - 4 populations extirpated since 2003 (USFWS, 2007)

**Number of Populations:**

8 (USFWS, 2022)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

There has been a documented decline in the spatial distribution and historic range of scrub lupine. As of 2003, the historical records of 40 populations had declined to 11 extant lupine populations occupying about 23 acres. Three or four of these populations have been extirpated since 2003, leaving six to seven scrub lupine populations (USFWS, 2007). There are a total of 8 known sites having at least 1 plant in existence surveyed for this review in 2022. Four locations occur on each ridge within the 2 counties (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat destruction, modification, and degradation on private lands remain the primary threat range-wide to the species. Populations occurring on private lands remain subject to adverse human activity, predominately development. Additionally, lack of management — especially fire suppression — on private lands degrades the habitat over time resulting in less suitability to maintain population viability. These human activities are no longer threats to populations on public conservation lands because of protection afforded and restricted use; however, budget constraints and prioritizing available resources may preclude proper, necessary management activities on conservation lands at times. Only three natural populations occur on public lands with the majority of the populations in private ownership. Little opportunity exists for future protection or management opportunities on these lands because of the urban matrix where they occur. (USFWS, 2016)

**Stressor:** Disease or predation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Several species of fungus have been observed on L. aridorum plant tissues: charcoal root rot (Macrophomina phaseolina), black leaf spot (Diplocarpon rosae), and recently an unknown black fungus. Little is known about the unidentified black fungus that appears to be confined to the seed coat on L. aridorum. The seed pod looks totally normal but upon opening it the fungus is apparently just on the seeds. Examinations of seed development (Stout 2016) in 2014 at the Lake McLeod NWR documented seeds from 11 of 15 plants (73%) were lost due to this fungal growth. Ten of 20 plants (50%) examined in 2015 had seed loss from fungal sources. No evidence of fungal infested seeds was detected in 2016 (30 plants in sample). Bacteria-induced wilt continues to be observed in L. aridorum populations. It is speculated that the bacteria blocks the conducting xylem tissue to the leaf. The sudden death of plants undergoing wilt may occur anytime during the year. Medium to large plants may be more subject to wilt than smaller recruits. Less than 5% of a population may die from this agent in a typical year. The moth, Uresiphita reversalis, has been a source of mortality to the lupine populations (L. aridorum, L. diffusus) studied during the last 5 years (Stout 2016). Stout (2016) documented roughly 200 L. diffuses individuals devastated by the larvae in one population with no evidence of any insects predating on the moth larvae. (USFWS, 2016)

***Recovery***

**Reclassification Criteria:**
Not defined. (USFWS, 1999).

Recovery Priority Number: 2C

**Delisting Criteria:**
1. Protect sites in Polk and Highlands counties, and establish a disturbance regime to create bare, sunny openings (USFWS, 2007).

2. Conduct demographic monitoring for the foreseeable future. Manage and rehabilitate publicly-owned habitats in Orange County (USFWS, 2007).

3. Manage and rehabilitate publicly-owned habitats in Orange County (USFWS, 2007).

**Recovery Actions:**
- Determine current distribution of L. aridorum. This species has an extremely restricted range. In South Florida, it is found only in northern Polk County off the Lake Wales Ridge. This species is found in a fast growing urbanizing area and essentially all of its habitat has been converted from the natural state. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of L. aridorum. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of L. aridorum. S4.1. Develop monitoring protocol to assess population trends for L. aridorum. Develop a quantitative description of the population structure of L. aridorum. (USFWS, 1999)
- Provide public information about L. aridorum. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where L. aridorum is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. The public should be informed that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of L. aridorum and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- Update and revise the recovery plan to improve and clarify the objective measurable criteria and better address the five factors. (USFWS, 2016).

- Collaboration with conservation land managers to increase habitat suitability of occupied habitat. Actively engage landowners to protect and manage occupied habitat. (USFWS, 2016)
- Continued research on biology and ecology: genetics; seed germination (soilmicrobial interactions); out planting techniques to reduce mortality; fungus and bacteria stressors. (USFWS, 2016)
- Conduct research on different habitat management techniques and their effects in regards to maintaining or improving the residual seed bank for populations. (USFWS, 2016)
- Increase existing monitoring efforts. (USFWS, 2016)

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence. • Actively engage landowners to protect, manage, and monitor occupied habitat. • Continued research on biology and ecology: genetics, seed germination (soil-microbial interactions), fungus and bacteria stressors. • Conduct studies of soil seed banks across the range on different habitat and seasonality for the restoration of degraded ecosystems and understanding the type of seed bank: transient, persistent, or transient: short-term and long-term persistent (USFWS, 2022).

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# SPECIES ACCOUNT: *Lupinus nipomensis* (Nipomo Mesa lupine)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

**Physical Description**

An annual herb (NatureServe, 2015). The low-spreading individuals can reach 8 inches (20 centimeters) in height (Riggins 1993). Leaves are pinnately compound into five to seven leaflets. Up to 10 pinkish-purple flowers are borne on the ends of the inflorescences (flowering stems). Leaves and stems are succulent, and provide prolonged moisture for seed development (USFWS, 2009).

**Taxonomy**

Recognized as distinct in Kartesz's 1999 Synthesis (had been questionable synonymized into Lupinus concinnus ssp. concinnus in the 1994 Checklist). Recognized as distinct by Jepson, CNDDB, and the 1999 Federal Register (NatureServe, 2015). A member of the pea family (Fabaceae) (USFWS, 2009).

**Historical Range**

Historically and currently, the species is known only from the southwestern corner of San Luis Obispo County, California, scattered over an area of approximately 2 miles wide and 2 miles long (3.2 by 3.2 kilometers (km)) (USFWS, 2009).

**Current Range**

It is currently extant at Nipomo Mesa, San Luis Obispo County, California (NatureServe, 2015). Colonies are scattered across a 2-mile (3.2-km) stretch of backdune habitat west of Highway 1 and between Black Lake Canyon to the north and Oso Flaco Lake to the south (USFWS, 2009).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2009)

**Lifespan**

Adult: One year (USFWS, 2009)

**Breeding Season**

Adult: March - May (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: Insect pollinators, based on closely related species (USFWS, 2009)

**Reproduction Narrative**

Adult: This is an annual species. Potentially, seed production could reach on the order of 1,000 seeds; however, based on 2 years of sampling, observed seed production per plant ranged from 1 to over 200, with most plants producing less than 30 fruits (Walters and Walters 1988). Flowers are self-compatible if manipulated; however, they may require insect visitation for full complements of seeds (Center for Plant Conservation (CPC) 2009). While pollination ecology has not been specifically studied for L. nipomensis, other lupine taxa are known to be pollinated by butterflies and a variety of bee taxa, especially from the genera Bombus, Osmia, Synhalonia, and Anthidium (Moldenke 1976) (USFWS, 2009). It blooms from March to May (NatureServe, 2015).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Coastal dune scrub (USFWS, 2009)

**Dependencies on Specific Environmental Elements**

Adult: Natural disturbance (USFWS, 2009)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs < 50 m elevation (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (inferred from USFWS, 2009)

**Habitat Narrative**

Adult: Inhabits stabilized coastal sand dunes at < 50 m elevation. (NatureServe, 2015). It is restricted to sandy soils associated with the Callender Dune Sheet (Cooper 1967). Habitat for Lupinus nipomensis is comprised of stabilized back dunes supporting a central coastal dune scrub community. Lupinus nipomensis needs open habitat to persist. Sandy soils along the coast typically undergo a certain amount of natural disturbance from coastal winds and from the activity of wildlife (USFWS, 2009).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Nipomo Mesa lupine has an explosive seed dispersal mechanism caused by the drying out of the seed pods (Walters and Walters 1989, p. 12). Like many other lupine species, it likely has a persistent seed bank (USFWS, 2024)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

3 (USFWS, 2024)

**Population Size:**

Variable; 81-343 (USFWS, 2024)

**Additional Population-level Information:**

There are currently three known extant Nipomo Mesa lupine EOs: Santa Maria Oil Refinery/Phillips 66 Petroleum Company (EO 1); Kathleen's Overlook Canyon ([KCO] EO 3); and BLEA (EO 10). VFWO visited areas within each EO with partners during the peak of the Nipomo Mesa lupine blooming season in April 2024. We observed the species at each location, assessed the threats, and noted overall habitat conditions. We were unable to access portions of EO 1 on the east side of the Southern Pacific Railroad at the Phillips site in April 2024. Phillips 66 gave VFWO and CDFW a tour of their property on July 11, 2023, which was not within the Nipomo Mesa lupine blooming period. We estimated that the population described at listing had fewer than 700 total individuals in the 2000 Listing Rule (Service 2000, p. 14890). Our previous 5-year reviews presented census data collected by LCSLO from 2006 to 2017 at selected locations within the Phillips 66 property (EO 1; CNDDB 2024b, website). The number of individuals within these selected monitoring plots ranged from 118 (2016) to 1,677 (2013) (Service 2019, p. 12). In 2017, LCSLO completed a comprehensive Nipomo Mesa lupine census survey throughout the Phillips 66 site and counted 911 total individuals. They also monitored Nipomo Mesa lupine at BLEA from 2015 through 2018. LCSLO and partners counted 118 Nipomo Mesa lupine individuals in 2015, 343 in 2016, 81 in 2017, and 89 in 2018 at BLEA (USFWS, 2024).

**Population Narrative:**

Lupinus nipomensis (Nipomo lupine) is a small annual plant in the pea family (Fabaceae). Historically and currently, the species is known only from the southwestern corner of San Luis Obispo County, California, scattered over an area of approximately 2 miles wide and 2 miles long (3.2 by 3.2 kilometers (km)) (Figure 1). It is restricted to sandy soils associated with the Callender Dune Sheet (Cooper 1967). For purposes of this review, we are considering the entire extent of the species to comprise one population; however, the California Natural Diversity Database (CNDDB) has divided the population into approximately 10 occurrences for tracking purposes. Over the last 4 years, the total number of individuals has fluctuated between approximately 139 and 771, depending on winter and spring climatic conditions (Land Conservancy of San Luis Obispo County (Conservancy) 2009). Over time, the species' habitat has been fragmented by State Highway 1 and oil refinery facilities, and bounded on the eastern side by development and agriculture. The small size of the populations and their proximity to a variety of human activities makes it vulnerable to stochastic extinction. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A Notice of Preparation to expand refinery capabilities at the Conoco-Phillips plant has been received (County of San Luis Obispo 2008). The Service has also recently received a notice regarding a proposal to construct a telecommunications facility less than 0.25 mile (0.4 km) away from EO #7 (C. Mehlberg, Service, in litt. 2009). The project proponent notes that the site was previously developed with agricultural fields; whether above-ground plants or a seed bank of L. nipomensis remains is unknown. In addition, it appears that several housing developments have

been constructed within a mile of L. nipomensis habitat over the past 5 years (Google Earth 2009). The presence of a larger human population in the adjacent area is likely to introduce additional direct and indirect effects (such as trampling from recreational use, spread of invasive horticultural species used in landscaping, and loss of pollinator habitat) on the species as time goes on. Little opportunity for population expansion is available adjacent to the existing populations because habitat has already been converted to other uses, including roads, facilities, agriculture, and housing (USFWS, 2009).

**Stressor:** Pocket gophers (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** While pocket gophers are known to harvest seeds of many species in general (Martin et al. 1951), it is more likely that they consume the roots, stems, and leaves of L. nipomensis, and that seeds die prior to full maturation. However, seed that are able to complete maturation despite being excised from the plant may find suitable germination sites in the vacated gopher mounds the following winter season (Walters and Walters 1988). In addition, the listing rule stated that the presence of veldt grass increases the food source for pocket gophers and thus potentially increases their numbers and their potential harm to L. nipomensis (Walters and Walters 1988). Survey results for the 3 years from 2007 through 2009 indicate that from 28 to 31 percent of L. nipomensis individuals are consumed by pocket gophers on Conoco-Phillips property (Conservancy in litt. 2009); therefore, pocket gophers continue to be a threat to the species (USFWS, 2009).

**Stressor:** Nonnative plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In general, invasion of this habitat by nonnative species (particularly veldt grass (see Bossard et al. 2000)) is a threat to populations of native species because individuals cannot compete well for light, water, and resources (D'Antonio and Vitousek 1992). Veldt grass was described as "rampant" in the area at least 25 years ago (McLeod and Walters 1987); its presence can cause a shift from scrub habitat to grassland habitat (Bossard et al. 2000, California Invasive Plant Council 2009). Since 2000, the Conservancy has been actively removing veldt grass from Lupinus nipomensis habitat. While these efforts may have slowed the conversion to a monoculture of veldt grass, it is likely that the habitat will have to be managed in perpetuity to maintain the open patches that is required by L. nipomensis (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The existence of less than 10 occurrences and the small number of individuals in the occurrences place Lupinus nipomensis at risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Groom et al. 2006; Primack 2006). In particular, although the plants are apparently self-compatible and capable of self-fertilization, the small size of the population makes it difficult for this species to

persist while sustaining the impacts of habitat alteration that favors nonnative plant species and the potential loss of pollinator habitat (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of increasing diversity shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Nipomo lupine may be considered for downlisting when the following criteria are met: 1. At least three resilient occurrences display stable or increasing population trends averaged over 10 consecutive years; 2. Each of the three resilient occurrences is protected from habitat loss, including development activities; 3. Each of the three resilient occurrences is being managed in a way that will support continued existence of Nipomo lupine and its coastal dune scrub habitat, including management of non-native, invasive species; 4. Management is effective as shown by monitoring for 10 consecutive years; and 5. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the species' genetic diversity. (USFWS, 2021)

Recovery Priority Number: 5

**Delisting Criteria:**
Once the downlisting criteria have been met, Nipomo lupine may be considered for delisting when the following criteria are met: 1. At least five resilient occurrences, are successfully established within the GuadalupeNipomo Dunes Complex, and display stable or increasing population trends averaged over 10 consecutive years; 2. Each of the five resilient occurrences is protected from habitat loss, including development activities; 3. Each of the five resilient occurrences is being managed in a way that will support continued existence of Nipomo lupine and its coastal dune scrub habitat, including management of non-native, invasive species; and 4. Management is effective as shown by monitoring for 10 consecutive years. (USFWS, 2021)

**Recovery Actions:**

- The recovery actions for Nipomo lupine are provided below. 1. Protect all currently unprotected habitat where the species occurs. The coastal dune scrub habitat associated with Nipomo lupine has a limited distribution and is considered a sensitive vegetation type. USFWS will work with potential partners to establish conservation easements, fee title agreements, or other appropriately protective measures on private lands that support the species and its habitat for conservation. 2. Conduct outplanting activities at suitable sites to establish new occurrences throughout the Guadalupe-Nipomo Dunes region. Potential outplanting locations include: • Kathleen’s Canyon Overlook – located along Black Lake Canyon, on the corner of Callender Road and State Route 1 in rural Arroyo Grande. The Land Conservancy of San Luis Obispo (LCSLO) recently purchased this 55-acre site for conservation purposes. • Coreopsis Hill – located south of Oso Flaco Lake, southwest of the town of Nipomo, and less than one mile directly inland from the Pacific Ocean. The site is jointly owned by California Department of Parks and Recreation, Oceano Dunes State Vehicular Recreation Area and private landowners that support environmental stewardship and long-term preservation of the property. However, a conservation easement for the site has not yet been established with the private entity. The site is approximately 60 acres. • USFWS Guadalupe-Nipomo Dunes National Wildlife Refuge (Refuge) – a 2,553- acre site located northwest of the town of Guadalupe and west of State Route 1. The property is part of a national system that is managed specifically for conservation purposes. • Guadalupe Oil Field – a remediation site for diluent contaminants that is owned and managed by Chevron Corporation in cooperation with several other agencies and partners. The property is located on the north side of the Santa Maria River and immediately south of the Refuge. It is 2,700 acres in size. • Dune Lakes Limited – a privately owned duck-hunting club located north of Black Lake and south of the town of Oceano. LCSLO holds a conservation easement on approximately 970 acres of this 1,255-acre property. • Oceano Dunes Natural Preserve – this property is part of the Oceano Dunes State Vehicular Recreation Area and is owned and managed by California Department of Parks and Recreation. The preserve area is approximately 500 acres and is located southwest of the town of Oceano. • Trilogy Dunes Open Space – this site is located southeast of the Phillips 66 Refinery and is designated as an open space preserve to offset impacts from two associated residential developments under the California Environmental Quality Act. The property is approximately 175 acres. 3. Manage habitat that supports the species to reduce or eliminate threats to the population (particularly non-native, invasive weeds) and to foster natural regeneration and recruitment of Nipomo lupine. 4. Collect seed and deposit accessions into the permanent conservation seedbank established for the species at the Santa Barbara Botanic Garden that includes additional backup sent to the U.S. Department of Agriculture’s National Laboratory for Genetic Resource Preservation seed vault, located in Fort Collins, Colorado. 5. Conduct annual census monitoring and experimental research projects across the occurrences to fill data gaps and document the progress of recovery implementation. 6. Determine those factors necessary for seed survival, optimal germination, and effective seedling establishment and use this information to ensure future recovery efforts. In particular, consider the role of disturbance, predation, and pollination on the species viability. 7. Conduct genetics and demographic research to better inform future recovery activities and criteria. Examples of potential projects include: • Investigate the effects of outplanting on the species genetic variability and compare variability of extant occurrences to that of propagated lines. • Determine the number of reproducing individuals required for population resiliency in any given occurrence. • Quantify seedbank longevity. 8. Develop opportunities for education and outreach within local and regional communities, and throughout San Luis Obispo County. (USFWS, 2021)

- Complete a Recovery Outline and Species Action Plan for Lupinus nipomensis as a first step in preparing a recovery plan for the species (USFWS, 2009).
- Work with Conoco-Phillips and California Department of Transportation to ensure that management of their lands and rights-of-way is consistent with the long-term persistence of

Lupinus nipomensis at those sites. In addition, work with the County of San Luis Obispo to ensure that consideration is given to L. nipomensis during projects review and implementation (USFWS, 2009).

- In partnership with Santa Barbara Botanic Garden, continue with research on seed characteristics, particularly to determine the extent of the soil seed bank present, and whether there is a difference in seed viability between those produced from self-fertilization and those produced by cross-pollination to determine if lack of pollinators is a concern (USFWS, 2009).
- In partnership with Santa Barbara Botanic Garden and the Conservancy, experiment with establishment of new populations in other coastal dune scrub habitat in coastal San Luis Obispo County (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Complete a Recovery Outline and Species Action Plan for Lupinus nipomensis as a first step in preparing a recovery plan for the species. 2. Work with Conoco-Phillips and California Department of Transportation to ensure that management of their lands and rights-of-way is consistent with the long-term persistence of Lupinus nipomensis at those sites. In addition, work with the County of San Luis Obispo to ensure that consideration is given to L. nipomensis during projects review and implementation. 3. In partnership with Santa Barbara Botanic Garden, continue with research on seed characteristics, particularly to determine the extent of the soil seed bank present, and whether there is a difference in seed viability between those produced from selffertilization and those produced by cross-pollination to determine if lack of pollinators is a concern. 4. In partnership with Santa Barbara Botanic Garden and the Conservancy, experiment with establishment of new populations in other coastal dune scrub habitat in coastal San Luis Obispo County. (USFWS, 2020)
- Trilogy Dunes Open Space – this site is located southeast of the Phillips 66 Refinery and is designated as an open space preserve to offset impacts from two associated residential developments under the California Environmental Quality Act. The property is approximately 175 acres. (USFWS, 2021)
- Clethodim Herbicide Study. Clethodim is a grass-specific herbicide widely used throughout the Guadalupe-Nipomo Dunes complex to manage veldt grass. ODSVRA maintains a California Endangered Species Act 2081(a) Management Permit (2081 permit) issued by CDFW to implement invasive species controls for Nipomo Mesa lupine recovery. Their 2081 permit authorizes them to conduct Clethodim applications at P66-west and implement other manual weed and treated thatch removal activities. In past years, CDFW required 100-ft avoidance buffers around areas occupied by Nipomo Mesa lupine where aerial Clethodim applications could not be sprayed. ODSVRA thus had to use manual techniques in buffer areas while avoiding the Nipomo Mesa lupine growing season. This was labor intensive, and the buffer areas were too large to be managed effectively. The buffers resulted in veldt grass islands that adversely affected the species and undermined treated areas by rapidly spreading seed back out into them. In 2020, ODSVRA proposed to amend their 2081 permit to reduce the size of the avoidance buffers. CDFW raised concerns that Clethodim may adversely affect Nipomo Mesa lupine growth, reproduction, and development. To address this, ODSVRA contracted CCBER to evaluate effects of Clethodim, applied either aerially or directly sprayed, on Nipomo Mesa lupine seedlings and reproductive individuals in a greenhouse setting (CCBER 2024, p. 2). CCBER also collected seeds from the treated individuals and germinated them to investigate potential effects of Clethodim on seed viability. CCBER found no significant effects from the Clethodim treatments on Nipomo Mesa lupine growth, reproduction, plant vigor, seed production, or seed viability (CCBER 2020b, p. 4–11). By November of 2022, CDFW reduced the width of the

Nipomo Mesa lupine avoidance buffers to 7.6 m (25 ft), but no less than 4.6 m (15 ft). CDFW also permitted direct Clethodim treatments in areas previously occupied by the species but where it was not observed for five years or more. These changes allow ODSVRA to conduct invasive species controls for Nipomo Mesa lupine recovery more easily and efficiently at P66- west (USFWS, 2024).

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Conduct comprehensive annual surveys of abundance, assess the overall status of the species, and evaluate current threats at each of the three EOs. Include estimates of the total number of Nipomo Mesa lupine individuals present at each location, using uniform methodologies suitable for trend analyses, and map the total occupied area. Collect other pertinent ecological and demographic data including co-occurring and co-dominant species, estimate of bare sand cover, presence and abundance of nonnative, invasive species, timing of phenology, effective population size, and continue observations of any potential insect pollinators, and seed and foliage herbivory. 2. Conduct experimental research to determine the most effective management techniques for occupied Nipomo Mesa lupine sites to ensure persistence and expansion of the species. We recommend evaluating the use of grazing and other disturbance techniques designed to manage nonnative, invasive weeds (especially veldt grass) to stimulate seed germination, to maintain sandy, open spaces required by the species, and to expand potentially suitable habitats immediately adjacent to occupied areas. 3. Conduct genetics research on Nipomo Mesa lupine to quantify the genetic diversity within the species and establish other important genetic baseline metrics for conservation. 4. Obtain conservation easements or acquire other sites within the species current range to introduce the species to new locations that have long-term management strategies to ensure success and persistence of the species. Refine existing protocols for propagation of the species from seed. 5. Continue making conservation seed bank accessions of Nipomo Mesa lupine seed. Conduct additional seed bulking activities to ensure an ample supply of seed for recovery efforts and for insurance in the event of stochastic loss or extirpation (USFWS, 2024).

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# SPECIES ACCOUNT: *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 02/24/2000; Pacific Region (R1)

**Physical Description**

Lupinus sulphureus ssp. kincaidii, a dicot herbaceous perennial, was first described in 1921 by A.A. Heller as Lupinus oreganus from a collection made in Eugene, Oregon (Wilson et al. 2003). In the intervening decades, Phillips (1955) described the plant as a subspecies, L. sulphureus ssp. kincaidii. Hitchcock (1961) retained the position noted by Phillips (1955), but preferred the combination as a varietal rank, L. sulphureus var. kincaidii, although this is not accepted under the rules of botanical nomenclature (Wilson et al. 2003). Additional taxonomic work may be needed for this subspecies, and it is possible that the subspecies should be considered a distinct species, L. oreganus (Wilson et al. 2003). (USFWS, 2010) This taxonomic change for Kincaid's lupine, from the subspecies Lupinus suiphureus ssp. kincaidii to the full species Lupinus oreganus, has now been recognized by the Oregon Department of Agriculture (Oregon Department of Agriculture, 2019) and by botanical authorities such as the Oregon Flora Project's Vascular Plant Checklist (laster et al. 2019) and the Flora of Oregon (S. Meyers pers. comm. 2019). Other authorities, such as the Natural Resources Conservation Service's USDA PLANTS database (USDA PLANTS 2019), the Integrated Taxonomic Tnformation System (ITIS.GOV 2019), the Flora of the Pacific Northwest (Hitchcock and Cronquist 2018), and Washington Department of Natural Resources (Washington Natural Heritage Program 2019, p. 19) now recognize Kincaid's lupine as a variety, Lupinus oreganus var. kincaidii C.P. Sm. (the other variety being L. oreganus var. oreganus, formerly L. biddlei). Whether a full species or an infraspecies, all authorities now agree that at a minimum, Kincaid' s lupine should be recognized under the specific epithet "oreganus" instead of "suiphureus." (USFWS, 2019)

**Taxonomy**

Lupinus sulphureus ssp. kincaidii was first described in 1921 by A.A. Heller as Lupinus oreganus from a collection made in Eugene, Oregon (Wilson et al. 2003). In the intervening decades, Phillips (1955) described the plant as a subspecies, L. sulphureus ssp. kincaidii. Hitchcock (1961) retained the position noted by Phillips (1955), but preferred the combination as a varietal rank, L. sulphureus var. kincaidii, although this is not accepted under the rules of botanical nomenclature (Wilson et al. 2003). Additional taxonomic work may be needed for this subspecies, and it is possible that the subspecies should be considered a distinct species, L. oreganus (Wilson et al. 2003). (USFWS, 2010) This taxonomic change for Kincaid's lupine, from the subspecies Lupinus suiphureus ssp. kincaidii to the full species Lupinus oreganus, has now been recognized by the Oregon Department of Agriculture (Oregon Department of Agriculture, 2019) and by botanical authorities such as the Oregon Flora Project's Vascular Plant Checklist (laster et al. 2019) and the Flora of Oregon (S. Meyers pers. comm. 2019). Other authorities, such as the Natural Resources Conservation Service's USDA PLANTS database (USDA PLANTS 2019), the Integrated Taxonomic Tnformation System (ITIS.GOV 2019), the Flora of the Pacific Northwest (Hitchcock and Cronquist 2018), and Washington Department of Natural Resources (Washington Natural Heritage Program 2019, p. 19) now recognize Kincaid's lupine as a variety, Lupinus oreganus var. kincaidii C.P. Sm. (the other variety being L. oreganus var. oreganus, formerly L. biddlei). Whether a full species or an infraspecies, all authorities now agree that at a minimum, Kincaid' s lupine should be recognized under the specific epithet "oreganus" instead

of “suiphureus.” (USFWS, 2017)

**Historical Range**

"Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid’s lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat" (USFWS, 2010 p. II-20).

**Current Range**

Douglas County, Oregon to Lewis County, Washington, and into southern British Columbia. Considered extirpated in British Columbia. In Oregon, in the Willamette and Umpqua Valleys. Kincaid's lupine is restricted to upland prairie habitat "Before Euro-Americans settled the Willamette Valley, prairies were one of the dominant habitat types, accounting for perhaps 30 percent of the valley floor (Altman et al. 2001). Prairies were created and maintained by natural and human-caused disturbances; the native Kalapuya peoples burned the prairies frequently to maintain high quality hunting and gathering grounds (Boyd 1986). As settlers arrived, native habitats were converted to agricultural landscapes, annual burning ceased, and native upland prairies and wet prairies now cover much less than one percent of their former area (Habeck 1961, Johannessen et al. 1971, Towle 1982), making them among the rarest of North American ecosystems (Oregon Natural Heritage Program 1983, Noss et al. 1995)." (USFWS 2010 p. I-5). "The majority of the habitat for Lupinus sulphureus ssp. kincaidii is on private lands, thus partnering with private landowners by working with nongovernmental organizations (e.g., land trusts), local governments such as soil and water conservation districts, and the Service’s Partners for Fish and Wildlife program is essential to achieve recovery." (USFWS 2019 p.7)

**Critical Habitat Designated**

Yes; 11/30/2000.

**Legal Description**

On October 31, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 30, 2006) for Lupinus sulphureus ssp. kincaidii (Kincaid's lupine) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 critical habitat units (CHUs) in Oregon and Washington (71 FR 63862-63977).

**Critical Habitat Designation**

The critical habitat designation for Lupinus sulphureus ssp. kincaidii includes 13 CHUs in Benton, Lane, Polk, and Yamhill Counties, Oregon, and Lewis County, Washington. This species critical habitat encompasses approximately 585 acres (ac) (237 hectares (ha)). Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule (71 FR 63862-63977; USFWS, 2006).

Unit KL–1 consists of approximately 4 ac (1.6 ha) of private land in Lewis County, Washington.

Unit KL–2A and 2B encompass approximately 6.25 ac (2.5 ha) and 14.1 ac (5.7 ha) respectively, of private land in northern Yamhill County. KL–2A supports Lupinus sulphureus ssp. kincaidii patches along both the east and west sides of Oak Creek Road. KL– 2B is located approximately

0.68 miles (1.1 km) south of KL–2A along both the east and west sides of Oak Creek Road, near the junction with Fairdale Road.

Unit KL–3 consists of approximately 51 ac (20.6 ha) of private lands within Yamhill County.

Unit 4 of Lupinus sulphureus ssp. kincaidii (Unit KL–4A and 4B) Unit KL–4A and 4B consists of approximately 68.6 ac (27.8 ha) of private lands in Yamhill County and is located west of Muddy Valley Road and south of Eagle Point Road.

Unit 5 of Lupinus sulphureus ssp. kincaidii (Unit KL–5) Unit KL–5 encompasses approximately 1.7 ac (0.7 ha) of ODOT land in southern Yamhill County and is located south of State Highway 18, east of Ballston Road, and approximately 0.6 mi (1 km) south of the Yamhill River.

Unit KL–6 encompasses approximately 3.6 ac (1.5 ha) of primarily ODOT land in northern Polk County. The Lupinus sulphureus ssp. kincaidii population occurs in two patches scattered along the northeast and southwest sides of Highway 22, near the intersection with Mill Creek Road.

Unit KL–7 consists of approximately 12.3 ac (5 ha) of private lands in central Polk County. This unit is located near the junction of Highway 223 and Oakdale Avenue, and largely falls within the City of Dallas urban-growth boundary.

Unit KL–8 consists of approximately 11.5 ac (4.6 ha) of private and State lands in Benton County. This unit occurs in McDonald Forest located off Oak Creek Road and supports one of the highest quality remaining prairies.

Unit KL–9 encompasses approximately 171.6 ac (69.4 ha) of private lands within Benton County. This unit is located in Wren, Oregon, between Kings Valley Highway, Cardwell Hill Road, and Blakesly Creek Road, approximately 2 mi (3.2 km) southwest of Unit KL–8.

Unit KL–10 consists of approximately 17.9 ac (7.2 ha) of private lands within Benton County and is located north of Philomath, with the habitat occurring primarily to the south of West Hills Road and to the west of 19th Street.

Unit KL–11 encompasses approximately 64.6 ac (26.2 ha) of prairie habitat distributed across Federal and private lands in Lane County. This unit is located in West Eugene, near the Fern Ridge Reservoir, just south of Clearlake Road, and on both the east and west sides of Fir Butte Road. The area included in Units KL–11A, 11B, 11C, 11D, and 11E.

Unit KL–12 encompasses approximately 141.2 ac (57.1 ha) of prairie habitat distributed across Federal and private lands in Lane County. This unit is in west Eugene and located north of Bailey Hill Road and west of Bertelsen Road. This unit primarily occurs on lands owned by TNC and the BLM, with 4 percent occurring on private lands. The area included in KL– 12A, 12B, 12C, 12D, and 12E, collectively represents habitat with the features essential to the conservation of a functioning Lupinus sulphureus ssp. kincaidii metapopulation.

Unit KL–13 encompasses approximately 16.2 ac (6.6 ha) of private land in Lane County, and is located north of Powell Road and west of Coyote Creek.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lupinus sulphureus ssp. kincaidii critical habitat consists of two components (71 FR 63862-63977):

(i) Early seral upland prairie, or oak savanna habitat with a mosaic of lowgrowing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils.

(ii) The presence of insect outcrossing pollinators, such as Bombus mixtus and B. californicus, with unrestricted movement between existing lupine patches.

**Special Management Considerations or Protections**

Lupinus sulphureus ssp. kincaidii populations respond positively to habitat restoration. Mowing, burning, and mechanical removal of weeds, when done appropriately, have all been shown to benefit Fender's blue populations. At sites managed by The Nature Conservancy (TNC), the Fender's blue butterfly and L. sulphureus ssp. kincaidii populations increased following removal of noxious non-native plants such as Rubus discolor (Himalayan blackberry) and Cytisus scoparius (Scotch broom) (Fitzpatrick 2005, pp. 6, 7, 10, 11, 20). At Baskett Slough National Wildlife Refuge in western Oregon, Wilson and Clark (1997, p. 10, 11) studied the effects of controlled fire and mowing on the Fender's blue butterfly and its native upland prairie. Although fire killed all larvae in treated patches, nearby unburned (untreated) patches provided a source of female Fender's blue butterflies that were able to recolonize the entire burned (treated) area. Wilson and Clark (1997, pp. 10, 23) also found that in the year following mowing and burning treatments, Fender's blue butterfly eggs were 10 to 14 times more abundant in treated plots than in undisturbed control plots. Woody plants were reduced by 45 percent with burning and by 66 percent with mowing. At the Corps' Fern Ridge Reservoir, the Fender's blue population has increased dramatically since fall mowing of L. sulphureus ssp. kincaidii patches has been implemented. The abundance of Fender's blue butterfly eggs and L. sulphureus ssp. kincaidii has increased as blackberry bushes have been controlled in several test plots located on BLM lands in Eugene, Oregon (Kaye and Cramer 2003, p. 10). In general, Fender's blue butterfly egg abundance increased substantially at sites treated to control non-native weeds (Schultz et al. 2003, p. 69). (USFWS, 2006)

Lupinus sulphureus ssp. kincaidii is at risk of inbreeding depression and site extirpation across their respective ranges because populations are small and isolated from one another. This species will benefit from reestablishing prairie plant patches in proximity to core populations. (USFWS, 2006)

Many remaining populations of Lupinus sulphureus ssp. kincaidii populations occur in road rights of ways and are adversely affected by maintenance activities such as mowing or spraying of herbicides at the wrong time of year. A few L. sulphureus ssp. kincaidii populations along roads persist, likely because the routine maintenance provides open, full-sun conditions characteristic of L. sulphureus ssp. kincaidii habitat.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2010) "Pollination is largely accomplished by small native bumblebees (Bombus mixtus and B. californicus), solitary bees (Osmia lignaria, Anthophora furcata, Habropoda sp., Andrena spp., Dialictus sp.) and occasionally, European honey bees (Apis mellifera) (Wilson et al.2003). Insect pollination appears to be critical for successful seed production (Wilson et al.2003). Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual clones can be several centuries old (Wilson et al.2003), and become quite large with age, producing many flowering stems." (USFWS 2010 p. II-22)

**Dependency on Other Individuals or Species**

Adult: "Pollination is largely accomplished by small native bumblebees (Bombus mixtus and B. californicus), solitary bees (Osmia lignaria, Anthophora furcata, Habropoda sp., Andrena spp., Dialictus sp.), and occasionally European honey bees (Apis mellifera) (Wilson et al. 2003). Insect pollination appears to be critical for successful seed production (Wilson et al. 2003)." (USFWS 2010 p. II-22) Kincaid's lupine is the larval host for the Endangered Fender's blue butterfly. (USFWS 2010)

**Breeding Season**

Adult: Flowering begins in April and extends through June (USFWS 2010). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al.2003) (USFWS, 2010).

**Reproduction Narrative**

Adult: Flowering begins in April and extends through June (USFWS 2010). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al.2003). Pollination is largely accomplished by small native bumblebees (Bombus mixtus and B. californicus), solitary bees (Osmia lignaria, Anthophora furcata, Habropoda sp., Andrena spp., Dialictus sp.) and occasionally, European honey bees (Apis mellifera) (Wilson et al.2003). Insect pollination appears to be critical for successful seed production (Wilson et al.2003). Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual clones can be several centuries old (Wilson et al.2003), and become quite large with age, producing many flowering stems. As part of a genetic evaluation, collections taken from small populations of Kincaid's lupine at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston et al.1995). Reproduction by seed is common in large populations where inbreeding depression is minimized and ample numbers of seeds are produced. In small populations, seed production is reduced and this appears to be due, at least in part, to inbreeding depression (Severns 2003). Kincaid's lupine is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles and weevils and larvae of other insects has been documented, and may result in substantially reduced production of viable seed (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (Glaucopsyche lygdamus columbia) has also been reported (Kuykendall and Kaye 1993). The vegetative structures of Kincaid's lupine support a variety of insect herbivores, including root borers, sap suckers and defoliators (Wilson et al.2003). Kincaid's lupine is the primary larval host plant of the endangered Fender's blue butterfly (Wilson et al.2003). Female Fender's blue butterflies lay their eggs on the underside of Kincaid's lupine leaves in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz et al.2003). Kincaid's lupine, like other members of the genus Lupinus, is unpalatable to vertebrate grazers (USFWS, 2016).

**Habitat Type**

Adult: Upland prairie (USFWS, 2010)

**Environmental Specificity**

Adult: Moderate (Inferred from USFWS, 2016)

**Habitat Narrative**

Adult: "In the Willamette Valley and southwestern Washington, Kincaid's lupine is found on upland prairie remnants where the species occurs in small populations at widely scattered sites. A number of populations are found in road rights-of-way, between the road shoulder and adjacent fence line, where they have survived because of a lack of agricultural disturbance. Some of the populations in Washington occur in pastures and appear to benefit from light grazing by livestock, which reduces the cover of competing shrubs and grasses (Joe Arnett, Washington Department of Natural Resources, in litt 2008). Common native species typically associated with Kincaid's lupine include: Festuca idahoensis ssp. roemeri, Danthonia californica, Calochortus tolmiei, Eriophyllum lanatum, and Fragaria virginiana. The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson et al.2003). In Douglas County, Oregon, Kincaid's lupine appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80% (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, in Douglas County, tree and shrub species dominate the sites, including Pseudotsuga menziesii (Douglas-fir), Quercus kelloggii (California black oak), Arbutus menziesii (Pacific madrone), Pinus ponderosa (ponderosa pine), Calocedrus decurrens (incense cedar), Arctostaphylos columbiana (hairy manzanita) and Toxicodendron diversilobum. In contrast to historical ecosystem composition, invasive non-native species are a significant component of Kincaid's lupine habitat today (USFWS 2010). Common invasives include: Arrhenatherum elatius, Brachypodium sylvaticum, Dactylis glomerata, Festuca arundinacea, Rubus armeniacus and Cytisus scoparius (Wilson et al.2003). In the absence of fire, some native species, such as Toxicodendron diversilobum and Pteridium aquilinum, invade prairies and compete with Lupinus sulphureus ssp. kincaidii" (USFWS, 2010).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2019)

**Resiliency:**

Moderate

**Representation:**

Moderate

**Redundancy:**

Moderate

**Number of Populations:**

21 - 80 (NatureServe, 2015) "The rangewide survey for Lupinus sulphureus ssp. kincaidii did not census every known occurrence of the species, but concentrated on those populations with the potential to contribute to the recovery goals for the species. Sites were selected for survey based on a priority system considering population size, connectivity with other populations, landownership, co-occurrence with Fender's blue butterfly, and date of most recent monitoring efforts. Small, isolated populations, especially those on private lands, were not prioritized for surveys. If sites had been monitored within the last 5 years, these sites were not resurveyed, but instead the most recent data were utilized in the report. As a result, the rangewide survey and monitoring report provides data from 84 populations of L. sulphureus ssp. kincaidii across its range (Ottombrino-Haworth et al. 2017, pp. 16, 23, 72–582). These 84 populations are distributed across six recovery zones for L. sulphureus spp. kincaidii as follows: 27 in Salem West, 26 in Corvallis West, 14 in Eugene West, 8 in Douglas County, 5 in SW Washington, and 4 in Eugene East. There are no known extant populations in the Corvallis East and Salem East recovery zones." (USFWS, 2019)

**Population Size:**

"Overall foliar cover has increased from an estimated range of 14,070 to 19,118 square meters (m2) (1.4 to 1.9 hectares (ha); 3.5 to 4.7 acres (ac)) at the time of listing to approximately 22,785 m2 (2.3 ha; 5.6 ac) today (Table 1). A few recovery zones have seen increases in foliar cover of L. sulphureus ssp. kincaidii since the 2010 5-year review, and in some cases those increases are quite large; these increases are primarily in the Corvallis West and Salem West recovery zones, where recovery efforts, including augmentation and outplanting of L. sulphureus ssp. kincaidii, have been concentrated in recent years. These zones have benefitted from the availability of seed specific to these areas (the lack of genetically appropriate seed sources is a continuing problem in many of the recovery zones), as well as the incidental advantage gained by L. sulphureus spp. kincaidii from being cultivated as the host plant for the endangered Fender's blue butterfly (Icaricia icarioides fenderi), which also occurs in those recovery zones. In contrast the foliar cover of L. sulphureus ssp. kincaidii has declined in the Douglas County and Southwest Washington recovery zones, and has remained roughly the same in Eugene West. However, as this most recent survey was the first rangewide effort using a standardized approach, at this point in time it is difficult to make any truly definitive assessments regarding population trend (Ottombrino-Haworth et al. 2017, p. 45). " (USFWS 2019 p. 4)

**Population Narrative:**

Kincaid's lupine is found in dry upland prairies from Lewis County, Washington, in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in the Willamette Valley (USFWS 2010). Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid's lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat. Range-wide, Kincaid's lupine is known at about 164 sites, comprising about 608 acres of total coverage

(USFWS 2010). In Oregon, the ONHIC (2014) reported Kincaid's lupine over 100 sites. From these locations, at least 43 populations are considered potential populations that could contribute to recovery (USFWS, OFWO, 2014, unpublished data); and 25 of those populations have protection in place for Kincaid's lupine. Until the summer of 2004, Kincaid's lupine was known from just two extant populations in Washington, in the Boistfort Valley in Lewis County, more than 160 km (100 miles) from the nearest population in the Willamette Valley (USFWS 2010). Arnett (2014) reported a total of 5 populations across 9 sites of Kincaid's lupine in 2014. At two sites, Kincaid's lupine covered more than 1,000 m2 (1,196 square yards)each (Boistfort and Cowlitz Prairie); only one plant was observed at Drew's Prairie in 2013. Only one location (Lozier Preserve within the Cowlitz Prairie population) has protection for Kincaid's lupine; all other locations are privately owned with no formal protections. Monitoring the size of Kincaid's lupine populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individuals (Wilson et al.2003). Instead of counting plants, most monitoring for this species relies on counting the number of leaves per unit area, partly because there is a strong correlation between Fender's blue butterfly egg numbers and lupine leaf density (Schultz 1998, Kaye and Thorpe 2006). Leaf counts are time consuming, however, and recent evaluations have shown that lupine cover estimates are highly correlated with leaf counts, much faster to perform, and useful for detecting population trends (Kaye and Benfield 2005) (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Plant succession (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. The vast majority of Willamette Valley prairies would likely be forested if left undisturbed. The natural transition of prairie to forest in the absence of disturbance such as fire will lead to the eventual loss of these prairie sites unless they are actively managed (Johannessen et al.1971; Kuykendall and Kaye 1993) (USFWS, 2016).

**Stressor:** Urbanization (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Urbanization is listed as a threat to this species. Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essentially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by Lupinus sulphureus ssp. kincaidii in 2000 at the time of listing were on private lands and are at risk of being lost unless conservation actions are implemented (USFWS 2000) (USFWS, 2016).

**Stressor:** Agriculture (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Agriculture is listed as a threat to this species (USFWS, 2016).

**Stressor:** Silviculture (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Silviculture practices are listed as threats to this species (USFWS, 2016).

**Stressor:** Roadside maintenance (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** Roadside maintenance is listed as a threat to this species (USFWS, 2016).

**Stressor:** Habitat fragmentation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of genetic variability
**Narrative:** Habitat fragmentation and isolation of small populations may be causing inbreeding depression in Lupinus sulphureus ssp. kincaidii. The subspecies was likely wide-spread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston et al.1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). Hybridization between Lupinus sulphureus ssp. kincaidii and Lupinus arbustus has been detected at Baskett Slough National Wildlife Refuge (Liston et al.1995)

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 6C

**Delisting Criteria:**
Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-5 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population (or area of foliar cover for Lupinus sulphureus ssp. kincaidii or Sidalcea nelsoniana) shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1 above must meet these criteria: (a) Prairie quality. Sites supporting populations of

the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (e.g., nest sites and food plants) for native pollinators. See Appendix D of the Recovery Plan for suggested criteria for evaluating prairie quality and diversity. (b) Security of habitat. For each listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species. (c) Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with Sidalcea nelsoniana or Lupinus sulphureus ssp. kincaidii should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species. (USFWS, 2010)

4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

**Recovery Actions:**

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their

historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)

- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)
- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)
- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans,

data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)

- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)
- Recommendation for Future Action from 2017 5-Year Review: Site naming conventions remain inconsistent and do not reflect “populations” as functional units. We recommend that a standard procedure for aggregating sites into populations be developed so that the Service and our partners can describe the number of populations in a more meaningful way. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: We recommend that the taxonomy of this species be reviewed as multiple names are currently being used for the same species. Naming conventions and genetics issues surrounding Kincaid’s lupine remain unresolved. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Management is imperative for prairie species to survive. Removal of woody species, control of invasive weeds and, in some cases, reintroduction of the once common native prairie matrix species may be necessary to maintain suitable habitat for Kincaid’s lupine. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Recovery of Kincaid’s lupine will require voluntary conservation by private landowners. The majority of this species’ habitat is privately owned and, due to the regulatory limitations, the Service is not able to prevent privately owned populations from being destroyed. Working with private landowners, conservation organizations, and local governments to conserve and protect Kincaid’s lupine is essential to achieving recovery. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: We recommend that the issue of hybridization be addressed through genetic analysis or crossing studies of Kincaid’s lupine. Current publications are limited to one known instance of hybridization between Kincaid’s lupine and spur lupine at Baskett Slough National Wildlife Refuge (Liston et al. 1 995). In order to determine the role of hybridization and the risk it poses to this species, additional genetic information is needed for Kincaid’s lupine populations throughout its range. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: The gaps in data evident in this analysis also indicate the need for accurate and up-to-date population (foliar cover) estimates for a number of sites. We recommend a complete survey effort to assess the status of all presumed extant populations of Kincaid’s lupine throughout its range. (USFWS, 2017)

- All of the General Plant Conservation Measures (Section 3.13.1) apply for Kincaid’s lupine. Additional species-specific measures include: • Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Kincaid’s lupine between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species. • All other broadcast applications will only occur after August 15 when Kincaid’s lupine is dormant. This plant is the primary host plant for Fender’s blue butterflies (another listed species); see additional PDC, restrictions, and conservation measures that apply for Fender’s blue butterfly (USFWS, 2016).

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# SPECIES ACCOUNT: *Lupinus tidestromii* (Clover lupine)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A creeping, perennial herb, 1-3 dm tall, rhizomatous. Roots bright yellow. Narrow leaves with 3-5 leaflets, arranged in a fan shape. Stems and leaves with short hairs. Inflorescence stems are 4-8 cm long, and whorls of flowers are blue to lavender. Fruits are pods containing 5-8 seeds with blackish spots (Fish and Wildlife Service 1997). (NatureServe, 2015)

**Taxonomy**

Lupinus tidestromii (Tidestrom's lupine) was described by Edward Greene in 1895 from an 1893 collection made by Ivar Tidestrom on the Monterey Peninsula. In 1938, Alice Eastwood described a similar lupine from Point Reyes (L. layneae). Philip Munz (1958) later recognized the Point Reyes plants as a variety of L. tidestrornii, and called them L. tidestrornii var. layneae to separate them from the Monterey Peninsula plants. The recent treatment by Rhonda Riggins and Teresa Sholars suggested that L. tidestromii exists as a single, variable species (Riggins and Sholars 1993) (USFWS, 1998).

**Historical Range**

Historically, Tidestrom's lupine was found extensively along the California coast (Service 2009, p. 17). At the time of listing, there were three geographically separate areas containing the species along the California coastal dunes: the southernmost populations were found at various sites on the northern tip of the Monterey Peninsula, the central populations were found in PORE, and a northern population was found at Goat Rock Beach on the Sonoma Coast State Beach (SCSB). There were also another two possible populations within the northern area in Sonoma County, one at Dillon Beach and the other at Bodega Head (Service 2009, pp. 5–6). According to the final listing rule, plants collected from Bodega Head in 1925 may have been misidentified as Tidestrom's lupine because of the limited dune habitat in the general area and the vegetative condition of the specimen (Service 1992, p. 27850). The Bodega Head population was most likely extirpated before listing and surveys have not found any evidence of the plants (D. Smith, Marin Chapter, California Native Plant Society, in litt. 2008, as cited in Service 2009). The population at Dillon Beach in Marin County has also likely since been extirpated, but follow-up surveys are needed to confirm At the time of our 2009 5-year review, populations existed at the same three sites described at the time of listing (Service 2009, p. 5). The current species distribution of Tidestrom's lupine remains limited to these three geographic locations (USFWS, 2023).

**Current Range**

This species is found in clustered colonies at 3 sites along the California coastal dunes: the southern most populations are found at various sites from Carmel Beach to Asilomar State Beach (ASB) on the northern tip of the Monterey Peninsula, the central populations are found in their highest numbers and concentration on Point Reyes National Seashore around Abbott's lagoon, and the northern most populations are found at Goat Rock Beach on the Sonoma Coast State Beach (SCSB). (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowering occurs from May through June (USFWS, 1998).

**Key Resources Needed for Breeding**

Adult: Bees/Insect/Wind (USFWS, 2023)

**Reproduction Narrative**

Adult: The life history of Lupinus tidestromii is largely unknown or the information is unpublished. Flowering occurs from May through June. L. tidestrornii is probably pollinated by bees (Moldenke 1976). Within populations, plants exhibit highly congested distributions. Most lupine seeds for all 5 coastal species can be found littered at the plant base. This and large seed size is consistent with localized limited dispersal, and limited long-distance dispersal by abiotic factors. Seeds of Lupinus are generally long lived and probably forms a persistent dormant seed bank. For seeds to germinate under natural conditions, the seed coat probably must be degraded (although not necessarily scarified, as by “sandblasting” by windblown sand). Lupinus tidestromii grows in stable to slightly mobile dunes, far from “sandblasting” habitats, so very slow microbial decomposition of seed coats of long-lived seeds is the more likely route to germination. This is not a species of accreting foredunes, and it has very low burial tolerance compared with larger dune plants of the pea family (e.g., Lupinus chamissonis and Lathyrus littoralis, which grow in highly mobile dunes). As a result, Lupinus tidestromii is confined to the vast stable deflation plains next to southern Abbotts Lagoon (USFWS, 1998). The life history of Tidestrom’s lupine is that of a short-lived perennial with a long-lived seed bank. Flowering occurs from May through June, and while this species has previously been classified as bee-pollinated, recent evidence supports other methods of pollination. During regular surveys of Tidestrom’s lupine populations at Point Reyes National Seashore (PORE), no bees or flying insects were observed near a Tidestrom’s lupine plant (Park Service 2022, p. 63). Ants have been observed on individuals in the PORE populations, but their role, if any, in pollination is unclear (Park Service 2022, p. 63). It is likely that the species is at least partly wind pollinated. Tidestrom’s lupine has also been documented to be highly capable of autonomous selfing, which has led to concerns of low genetic diversity, especially for small populations (Coppoletta 2005, pp. 18–19). Within populations, plants exhibit highly clumped distribution. Seeds are large and usually found littered around the plant base. Seeds are generally long lived and form a persistent dormant seed bank. They require some type of seed coat degradation, such as scarification in blowing sand, in order to germinate. Additionally, researchers at Washington University have documented mature Tidestrom’s lupine individuals that go through nonreproductive phases where no flowers or seeds are produced (USFWS, 2023).

**Habitat Type**

Adult: Coastal dunes (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (Inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (Inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species occurs on partially stabilized coastal dunes up to about 8 m high in the mild maritime climate of the central California coast and grows in coastal dune communities in association with Menzies' wallflower, sand gilia, beach sagewort, sand verbena, and mock heather (Fish and Wildlife Service 1997) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the limited number of known locations.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are generally long lived and probably form a persistent dormant seed bank. Very slow microbial decomposition or long term erosion of the seed coat from sand scarification is the likely route for germination. This species has a very low burial tolerance and does not survive in accreting foredune formations. In addition, Dr. Knight believes that historically, large storms moved extensive areas of sand and brought deeply buried seeds to the surface where they could germinate (USFWS, 2009).

***Population Information and Trends***

**Number of Populations:**

12 (USFWS, 2023)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

The nineteen extant populations consist of 433 individuals (Fish and Wildlife Service 1997). Known from nineteen extant populations (Fish and Wildlife Service 1997). (NatureServe, 2015) While there were no abundance estimates available at the time of listing, our 1998 Recovery Plan documented 19 extant occurrences containing a total of 433 individuals of Tidestrom’s lupine within the three disjunct geographic areas mentioned above (Service 1998, p. 49). At the time of our 2009 5-year review, there were 16 known extant occurrences: nine within PORE, six in the Monterey peninsula (four on private land, one on City of Pacific Grove/U.S. Coast Guard property, and one on California State Park property), and one in Sonoma County at SCSB (Service 2009, Appendix A). Between 2001 and 2005, PORE implemented a formal sampling scheme for Tidestrom’s lupine populations within their jurisdiction (Park Service 2022, p. 33).

Surveys for most populations have continued through 2021 (Park Service 2022, p. 33). Census estimates in our 2009 5-year review varied and were not provided for all occurrences; however, general trend information was provided for most. At the time of our 2009 5-year review, the populations at PORE were considered stable or declining, the population at SCSB was increasing, and the southernmost populations that had been surveyed were considered stable (Service 2009, p. 21). Since our 2009 5-year review, two populations in the Monterey Peninsula (Diversity Database # 5 and 11) that were historically present were not found during a 2021 survey (Parr 2021, pp. 6- 7). Two populations at PORE (Diversity Database # 16 and 24) have had significant habitat degradation and were not found during surveys in 2001 and 2014 respectively (Park Service 2022, pp. 38, 45-46). Follow-up surveys are needed to confirm the presence or absence of individuals at these occurrences. Currently, there are 12 known extant occurrences of Tidestrom's lupine (Table 1). The largest population occurs over 50 acres of open dune habitat southwest of Abbott's Lagoon in PORE (Diversity Database # 13) and in 2021 was estimated to contain over 150,000 individuals (Park Service 2022, p. 46). The population at Goat Rock Beach in Sonoma County (Diversity Database # 17) has not been surveyed since 2011; however, the population numbers are believed to be stable at around 1,000 individuals (USFWS, 2023)

***Threats and Stressors***

**Stressor:** Commercial and residential development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Commercial and residential development along coastal communities continues to be the primary threat to habitat loss while trampling from hikers and livestock, and dune stabilization from invasive species are also contributing threats. These threats are considered to be current and foreseeable and this factor is still valid (USFWS, 2009).

**Stressor:** Predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Disease is currently not considered a threat to the species; however, predation from small mammals is considered to be a new current and foreseeable threat factor in this analysis. It is recommended that this threat be addressed in the recovery delisting criteria number 3 (Habitat and populations will be free of invasive weeds) as invasive weeds provide shelter for the mammals who prey on the seeds of L. tidestromii (USFWS, 2009).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1992. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2009).

**Stressor:** Hybridization (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Extirpation
**Narrative:** Hybridization from L. chamissonis in the Monterey Peninsula is considered to be a new, current and foreseeable threat factor in this analysis. This new threat was not considered in the original listing for Lupinus tidestromii and should be considered a new recovery criterion for the Monterey Peninsula populations (USFWS, 2009).

**Stressor:** Invasive species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Invasive species continue to be a very significant threat with habitat loss and hybridization. The threat of invasive species is currently being addressed and managed on protected sites; however, unsecured private lands have no protection against such threats (USFWS, 2009)

**Stressor:** Trampling (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of indivduals
**Narrative:** Trampling by both humans and livestock is considered a threat to this species (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts to the species under predicted future climate change are unclear. Current forecasts of warming are expected to raise mean temperatures and sea levels along of coast of western North America (IPCC 2007). While it appears reasonable to assume that the species may be affected, we have no knowledge of more detailed climate change information or literature specifically for this species. We lack sufficient information to predict with certainty the extent of effect that climate change along the California coast will have on the species. We do not know when or how the changes may occur, the potential changes to the ecosystem, or the level of threat posed by seasonal changes, rising mean temperatures and rising sea levels on the habitat (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Secure habitat for the species at current known occurrences (USFWS, 2009).

Management measures at the secured habitat locations (USFWS, 2009).

Monitoring of recovery for the secured habitat locations (USFWS, 2009).

Additional restored habitat (USFWS, 2009)

Recovery Priority Number: 5

**Delisting Criteria:**
15 years of monitoring (USFWS, 2009).

Reintroduced populations within historic range through natural means (USFWS, 2009).

Habitat and populations will be free of invasive weeds (USFWS, 2009).

Average of 10,000 individuals and progress toward the eradication of beach grass and iceplant at PORE (USFWS, 2009).

Private land occurrences protected, endowments secured and managed for recovery (USFWS, 2009).

Historic populations at Dillon Beach are restored and occupied (USFWS, 2009).

**Recovery Actions:**
- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. Habitat at PORE, ASB and SCSB has been secured for the species; however, these current protections are not permanent. Point Reyes National Seashore has designated the majority of areas that contain Lupinus tidestromii and other federally listed plants as “wilderness” providing protection under the National Parks Service regulations regarding wilderness. This encompasses approximately 33,000 acres and contains greater than 50 percent of the individuals as of the 2008 census (PORE LUTI report 2008). This percentage varies yearly depending on stochastic population fluctuations. Asilomar State Beach has designated 25 acres of dune habitat that contain L. tidestromii and other listed species as a Natural Dune Preserve under the California State Parks regulations and is protected by such definition. From a census conducted in 2000 the preserve contains approximately 40 percent of the genetically pure (unhybridized) individuals on ASB (Madison, pers. comm. 2009). A new comprehensive census for L. tidestromii is being conducted in 2009 and will include a determination of pure and hybrid populations. Although the “wilderness” and “Dune Preserve” designations provide a higher level of protection for the listed plant and its habitat, these protections can be changed or altered through a policy change or redesignation. Sonoma Coast State Beach currently has no extra protections for the areas that contain the listed plant other than those provided by the California State Parks regulations regarding protected species on State Parks lands. Pebble Beach and Spanish Bay golf courses have protected habitat with a mitigation agreement from the private land owner. The City of Carmel has designated the North Dune an Environmental Sensitive Habitat Area (ESHA). This designation does not provide any physical protections for the plant; however, it does provide limited protection against development unless this designation is removed or changed. Several private land occurrences on the Monterey Peninsula still remain unprotected. This private land protection on the Monterey Peninsula was a criterion in the Recovery Plan; however, this criterion for private land occurrences may not be feasible at this time with the threat of hybridization in the

Monterey Peninsula populations. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed; however, they are not complete. Monitoring efforts at PORE, SCSB and ASB are currently in their 8th year and are planned through 2015. Monitoring on public and private land occurrences are being performed through public city efforts; however no plan has been enacted or planned through a future date. Monitoring has also been done sporadically by California Native Plant Society (CNPS) for the Monterey Peninsula populations on private land when access has been granted. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is currently being addressed. Management measures are not permanent and could be altered or withdrawn depending on the status of the protections afforded the species. Management for recovery of the species has been implemented for the secured habitat sites at PORE, SCSB and ASB. Point Reyes National Seashore is under management through National Parks Service and SCSB and ASB are under management through California State Parks. Management plans have been written for all three locations through their respective agency with regards to recovery of the species and include reduction of effects from recreation use of the parks, invasive plants removal, and dune restoration efforts. Pebble Beach and Spanish Bay golf courses in Monterey County also have management plans for the continued conservation and protection of the plant on their respective properties. The City of Carmel North Dune is not considered a secured habitat, but the city has adopted several shoreline management plans and is currently in the process of creating a long term management plan for the North Dune population. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: The criterion is still valid and is being addressed; however, no new occurrences beyond the extent of the populations described from the time of listing and in this review have been identified. The populations at PORE and SCSB have increased in individual numbers since the time of listing, but naturally reintroduced populations on the Monterey Peninsula are generally hybrids and currently being removed. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, this criterion has been met and has been addressed. Monitoring for recovery has been implemented at the PORE, SCSB, and ASB secured habitat sites. Research efforts by Dr. Knight and her colleagues include extensive monitoring at PORE. Monitoring for SCSB is being conducted currently by State ecologist Brendan O’Neil. Point Reyes National Seashore monitoring includes individual population counts, observing for invasive plants, small mammal predation, habitat and plant (L. tidestromii) condition. Sonoma Coast State Beach populations are being monitored for rough population counts, effects from human recreational use, habitat and plant (L. tidestromii) condition. Asilomar State Beach is being monitored for rough population counts, effects from human recreational use, and

hybridization effects. Pebble Beach and Spanish Bay golf courses have private monitoring in accordance with the mitigation agreement which includes monitoring for rough population stands. The City of Carmel North Dune is not considered a secured habitat; however, the population has been monitored and the City's ESHA designation has general monitoring incorporated in the program. This monitoring effort is superficial; it is not guaranteed and is not specific for the listed plant. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. At the time of listing there was no substantial dune restoration or invasive weed removal efforts. Currently, extensive dune restoration efforts are ongoing at PORE. Sonoma Coast State Beach and ASB are conducting minor dune restoration efforts and continual invasive weed removal. Although these efforts have been enacted, invasive weeds have not been completely removed at any of these locations and will most likely be a continual threat Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, additional restored habitat is being created at the PORE and SCSB sites to extend the range of Lupinus tidestromii at those sites. Dune restoration efforts are being conducted on several sites along the California coast; however no restoration efforts specifically for L. tidestromii are being conducted. The seed life for L. tidestromii is considerably long, so these other dune restoration efforts may provide new occurrences for L. tidestromii provided there is a viable seed bank. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. Efforts are currently being conducted and progress towards both criterions has shown positive trends toward meeting recovery. The largest population, located near Abbott's Lagoon is estimated to have over 100,000 individuals, and this number has persisted since 2001. The dunes near Abbott's Lagoon have received a great deal of restoration attention from 2002-2006 (Ammophila arenaria removal). The second largest population, located on the dunes west of the Mendoza Ranch, was estimated at 32,528 individuals in 2003 whereas a 2007 census by Dr. Knight et al. estimated 11,668 individuals. The third largest population at PORE, located on the dunes near the Davis residence declined from 982 individuals in 2003 to 159 individuals in 2007, likely due to encroachment of iceplant. Removal of beach grass and iceplant surrounding this population was conducted in July 2008 through the mechanical removal of the beach grass (digging 3m into the ground and overturning this invasive grass) and hand removal of the iceplant. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Delisting Criteria: Is the criterion valid and have they been addressed: Yes, securing private lands for recovery is still a valid criterion; however, with the current information regarding the hybridization and until the threat of hybridization can be addressed this criterion may become obsolete for the Monterey Peninsula populations unless genetically pure individuals can be reintroduced. No private land occurrences other than Pebble Beach and Spanish Bay

golf courses are currently or under process for endowment or managed for recovery at the time of this review. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Is the criterion valid and have they been addressed: Yes, the criterion is still valid; however, currently no efforts are being made at Dillon Beach for the reintroduction of Lupinus tidestromii. This criterion would be considered vital to the expansion of the species. Dillon Beach provides highly suitable habitat, but is under threat of development and high human usage. More controlled conservation measures would need to be enacted before reintroduction could take place naturally or through manned efforts. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Delisting Criteria: Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Continue Dune restoration and eradication of invasive plants at PORE and SCSB (USFWS, 2009).
- Continue monitoring at PORE, SCSB and ASB. Establish structured monitoring plan for Monterey Peninsula populations on private lands (USFWS, 2009).
- Secure further conservation easements and/or acquire lands for protection of Monterey Peninsula populations (USFWS, 2009).
- Continue research of hybridization and seed predation threats (USFWS, 2009).
- Conduct accurate census of the Monterey private land occurrences (USFWS, 2009).
- Examine and implement dune restoration efforts for repopulation at Dillon Beach (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Tidestrom’s lupine. Some of these recommendations have already been discussed in previous recovery documents (Service 1998; Service 2009) and remain valid. A list of recommended future actions for each population is included in Appendix C. 1. Habitat management and restoration. Habitat loss and degradation as a result of development and invasive plant species continue to be the primary threat to Tidestrom’s lupine. To aid in the recovery of this species, additional restored habitat should be created through the removal of invasive plant species. Two secured locations, Goat Rock Beach and PORE, have particularly high potential for the creation of additional restored habitat for Tidestrom’s lupine. PORE has conducted several large-scale dune restoration projects that involved the removal of European beachgrass, iceplant, and other invasive plant species (Appendix B; Park Service 2022 pp. 8–15). Continued removal of invasives within past restoration areas should help to keep Tidestrom’s lupine established in those areas and reduce deer mice seed predation pressure (Dangremond et al. 2010, pp. 2265– 2266; Pardini et al. 2018 p. 1193). Future restoration projects that involve the creation of newly suitable habitat and reintroductions into this habitat could increase connectivity and genetic health. The Tidestrom’s lupine population at Goat Rock Beach (Diversity Database #17) responded favorably to past restoration efforts and may be a good fit for future management actions. After a restoration project at Goat Rock Beach in 2002 that involved the removal of invasive plant species, the Tidestrom’s lupine population at this location increased from approximately 400 individuals to over 1,000 individuals as a result of a natural expansion into the newly bare sand dunes (O'Neil pers. comm. 2021). State Parks removes weeds within this population annually to prevent the invasion of non-native species and because of these efforts the Goat Rock Beach population has remained stable for almost ten years (O'Neil pers. comm. 2021). Habitat restoration in other parts of SCSB, in conjunction with reintroductions into the newly created suitable habitat, would increase the distribution and redundancy of this species as currently the single population at Goat Rock Beach is the only population north of PORE. If possible, non-natives should be mechanically removed from an area or sprayed with herbicide and then mowed or scraped to accelerate decomposition. Herbicide treatments alone can result in standing dead biomass that lasts for years before decomposing, impeding colonization of native species during that time (Parsons pers. comm. 2021). Additionally, as the Monterey Peninsula populations have been shown to be genetically distinct from those at PORE, occurrences on private lands should be protected and occurrences on public lands should be managed through the continued removal of invasives. 2. Fencing of dune habitat and/or use of boardwalks where Tidestrom's lupine occur. For populations where trampling by humans and/or off-leash dogs is of concern, fencing should be installed to demarcate sensitive dune habitat. Signs identifying environmental sensitive areas may also help keep visitors from entering the dune habitat. In highly trafficked areas in the Monterey Peninsula, cable guideline fencing has proven ineffective in preventing people and off-leash dogs from entering the dune habitat and trampling Tidestrom's lupine (Dorrell-Canepa pers. comm. 2021). Instead, the installation of wood fencing is recommended to separate and protect sensitive dune habitat in places like North Dunes in Carmel-by-the-Sea (Diversity Database # 8) where there is considerable foot traffic. Another option would be establishing boardwalks such as those at ASB (Diversity Database #4), which have appeared to be effective in keeping the public from trampling Tidestrom's lupine (Gray pers. comm. 2021). 3. Reintroductions. Reintroductions into secured habitat should be conducted to increase the redundancy of Tidestrom's lupine. Currently there is only a single population in Sonoma County at Goat Rock Beach, thus putting the northern region at risk of extirpation from a catastrophic event or impacts from climate change. Reintroductions into suitable habitat within Sonoma Coast State Beach is recommended. Additionally, reintroductions into suitable habitat within the Monterey Peninsula could help increase population numbers and expand population ranges to increase resiliency. For example, ASB had relatively low population numbers during the most recent survey in 2021 and could benefit from reintroductions in unoccupied areas with suitable habitat. Reintroductions should also be performed in conjunction with habitat restoration if natural recolonization fails to occur. 4. Caging individual Tidestrom's lupine plants. In areas with significant deer predation, caging of individual plants during flowering and fruiting season is recommended. Asilomar State Beach has had success with chicken-wire cages installed once the plants start flowering in the winter and early spring and removed in the summer once the plants go to seed (ASB 2017, pp. 1–2). Inverted gopher baskets have also been used at North Dunes in Carmel-by-the-Sea to protect newly transplanted seedlings from herbivory (Dorrell-Canepa 2020, p. 8). In populations with known herbivory by grazers, cages should be installed prior to the reproductive season on as many Tidestrom's lupine individuals as possible to increase the chances of recruitment. 5. Controlling for hybridization with Chamisso bush lupine. Hybridization of Tidestrom's lupine with Chamisso bush lupine is a primary threat to the Monterey peninsula populations. When Chamisso bush lupine is found at ASB and North Dunes in Carmelby-the-Sea the plants are removed. Hybrids, which can be identified by their size and growth patterns, are also removed (ASB 2018, pp. 2–3; Dorrell-Canepa 2020, Appendix E). Removal of true Chamisso bush lupine and known hybrids should continue to occur. 6. Research. Additional research on Tidestrom's lupine ecology and threats would help land managers understand which factors are affecting population viability. Specifically, research into genetic diversity between and among populations may help explain why some populations at PORE have continued to decline despite active management and if seed translocations would be beneficial for declining populations. An investigation into how the species is pollinated would also help identify what factors may be affecting recruitment. Research into the dominant mating strategy of this species (outcrossing vs. selfing) would be helpful in identifying the level of inbreeding occurring. Additionally, research into potential fitness effects from rust fungus and ant predation will be necessary to determine if those threats warrant future attention. 7. Monitoring. Annual monitoring of all populations is recommended to track population trends and determine how populations respond to management efforts. As this species is a short-lived perennial, population fluctuations are expected, and regular population monitoring will help managers identify overall population trends. At a minimum, monitoring should consist of annual population counts or estimates, depending on the size of the population. More detailed information concerning whether an individual is a seedling, non-reproductive plant, or reproductive plant would allow more precise population tracking and is recommended when possible. Additional observations on plant health, signs of predation, disease, and hybridization should be documented when possible (USFWS, 2023).

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# SPECIES ACCOUNT: *Lysimachia asperulaefolia* (Rough-leaved loosestrife)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 7/13/1987; Southeast Region (R4)

**Physical Description**

A perennial rhizomatous herb, with erect stems 30 to 60 centimeters (cm) tall. Leaves are sessile in whorls of 3 to 4, are broadest at the base (0.8 to 2 cm wide), and have three prominent veins. The upper surface is deep yellow-green or blue-green and lustrous; the leaf margins are entire and slightly revolute (Figure 1). The yellow bisexual flowers are borne in a loose, cylindrical, terminal raceme, 3 to 10 cm long. The corolla is 1.5 cm across. There are usually five petals that have ragged margins near the apex and that have dots or streaks. The anthers are yellow-orange, and the style tapers to the simple stigma. The fruit is a capsule. Stipitate glands are usually present on most parts of the plant. Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October. Although the plants are dormant in the winter, they are easy to find in the fall because of the distinctive leaf pattern and the reddish color of the leaves. (USFWS, 1995)

**Taxonomy**

Lysimachia asperulaefolia was described by Jean Louis Marie Poiret in 1814. Since listing as endangered in 1987, there have been no changes to the nomenclature of the species, however some references now spell the specific epithet as “asperulifolia” an orthographic variant of “asperulaefolia.” In addition, in the listing documents and the Recovery Plan, the common name is referred to as Rough-leaved Loosestrife; however, some references use the common name Rough-leaf Loosestrife. Ironically, the leaves are actually smooth in texture. The genus Lysimachia is now considered to be part of the Myrsinaceae family and not the Primulaceae family (Weakley 2012). (USFWS, 2014)

**Historical Range**

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. (USFWS, 1995)

**Current Range**

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. Twelve counties in North Carolina; one county in South Carolina. (USFWS, 2014)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowering is from late May to early June (USFWS, 1995).

**Reproduction Narrative**

Adult: The first spring shoots of L. asperulaefolia appear in late March or early April. Flowering begins in late May and extends through mid to late June. L. asperulaefolia is an obligate out-crossing species, pollinated by solitary bees: most of the pollinators are in the genus Dialictus. Pollinators were found to be scarce and inefficient, perhaps contributing to low natural fruit and seed set. Fruit and seed set were much higher when flowers were artificially pollinated (Frantz 1984). Another possible explanation for low fruit and seed set is that populations are highly clonal, with several shoots arising from one rhizome. Since self-fertilization does not occur, pollinator activity among ramets would not result in seed set. Fruits are visible within 3 weeks of fertilization, but capsules do not dehisce until October. An average of 3.2 capsules are produced by flowering stems, with an average of less than two seeds per capsule. In one germination trial, 85 percent of the seeds germinated (Frantz 1984). While fruit and seed set are low, this is not unusual for a perennial species that apparently has a life strategy based largely on rhizomatous growth and therefore does not depend upon sexual reproduction and seedlings for short-term survival (USFWS, 1995). Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October (USFWS, 1995).

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Rough-leaf loosestrife occurs most often in ecotones between longleaf pine uplands and pond pine pocosins in moist, sandy or peaty soils with low vegetation that allows for abundant sunlight to the herb layer (USFWS 1993). Fire is primarily responsible for maintaining low vegetation in these ecotones which have been documented to occur between the following habitat types: longleaf pine savanna and pocosin; longleaf pine flatwood and pocosin; longleaf pine savanna and mixed herb; longleaf pine-pond pine and evergreen shrub; longleaf pine/wiregrass savanna and Carolina bay pocosin; Streamhead Pocosin and Pine/Scrub Oak Sandhill; and Sandhill Seep and Pine/Scrub Oak Sandhill (NCNHP 1993). This species often spreads from the ecotone into the open edges of the bordering habitats, for example into longleaf pine savannas and low shrub communities of Carolina bays. Other habitats and community types in which it has been found include: Low Pocosin, High Pocosin, Wet Pine Flatwoods, Pine Savanna, Streamhead Pocosin, and Sandhill Seep (Schafale and Weakley 1990), as well as creek flood basins, pond and lake margins, boggy seeps and meadows, boggy pools in shrub pocosins, and disturbed areas such as roadside depressions, powerline rights-of-way, firebreaks, and trails. In the NC Sandhills, Lysimachia asperulifolia prefers to be in lower parts of the ecotone, well within the shrub zone, even when such ecotones are well-burned. On Fort Bragg, a sizeable occurrence was found in a shrub ecotone/pocosin that had burned within four months of its discovery; most shrubs there had been 2 meters or more tall prior to burning. Low Pocosins occur in areas with deep peat overlaying wet sands and in Carolina bays. They are nutrient-poor, seasonally saturated, and dominated by a dense shrub layer, kept small by low nutrients and severe fires. L. asperulifolia occupies openings in the dense shrub layer (USFWS 1993). Rough-leaf loosestrife is also found in the ecotones between Wet Pine Flatwoods or Pine Savannas and High Pocosins where the water table is near the surface during winter and early spring. If burned, these ecotones remain open with characteristic grasses, herbs, and low shrubs (USFWS 1993) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: No information available.

***Population Information and Trends***

**Population Trends:**

See narrative.

**Number of Populations:**

53; 52 in NC and 1 in SC (USFWS, 2021)

**Population Narrative:**

When the recovery plan was prepared in 1995, Lysimachia asperulaefolia was known from the southeastern coastal plain of NC and the sandhills of NC and SC. Since the 2014 5-Year Review, 12 new sub-populations (sub-EOs) were discovered in NC. Currently, state natural heritage programs recognize 53 extant populations or principal EOs (52 in NC and one in SC). Since the 2014 5-Year Review, natural heritage program records indicate that the ranks of three populations have improved while six populations declined, indicating that those populations have fewer stems than previously observed, or possibly even disappeared. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Residential and commercial development are listed as threats to this species (USFWS, 2014).

**Stressor:** Road construction (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Road construction is listed as a threat to this species (USFWS, 2014).

**Stressor:** Silviculture (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Silviculture (pine plantations) are listed as a threat to this species (USFWS, 2014).

**Stressor:** Wetland draining/filling (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Wetland draining and/or filling are listed as threats to this species (USFWS, 2014).

**Stressor:** Herbicide use (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Herbicide use, especially on road shoulders and powerline rights of way has potential to quickly cause negative impacts to this rhizomatous perennial (USFWS, 2014).

**Stressor:** Herbivory (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Herbivory (likely by deer) is listed as a threat to this species (USFWS, 2014).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of federal listing, this species was also listed as state endangered by the State of North Carolina under the Plant Protection and Conservation Act of 1979 (North Carolina Code Article 19B, § 106-202.12; NC Act). The NC Act provides limited protection from unauthorized collection and trade of plants listed under that statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities (Robinson and Finnegan 2014). The NC Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat, but that agency has not yet created any nature preserves for this species (USFWS, 2014).

**Stressor:** Fire suppression (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Fire suppression was also identified as a serious threat. The lack of fire in the habitat where this species occurs allows woody species to grow and compete for sunlight, eventually shading out this low growing species. The exclusion of fire also affects nutrient cycling and insect populations (USFWS, 2014).

**Stressor:** Small population size (USFWS, 2014)

**Exposure:**
**Response:**
**Consequence:** Loss of populations
**Narrative:** Populations that are small in size and number of individual plants are vulnerable to stochastic events (USFWS, 2014).

***Recovery***

**Reclassification Criteria:**
1. Management plans have been prepared and are being implemented for all publicly owned population centers and those owned by The Nature Conservancy (USFWS, 1995)

2. Populations at these centers have been monitored for at least 5 years and are determined to be stable. (USFWS, 1995)

Recovery Priority Number: 8

**Delisting Criteria:**
1. When the reclassification criteria are met and a binding management agreement for each population center is in place (USFWS, 1998)

**Recovery Actions:**
- 1. Protect significant sites and adjacent habitat. - Map all sites and mark sites in the field (except where there is ready public access and where signs would increase the threat of collecting): include in the marked area the adjacent habitat and buffer. - Map and search appropriate habitat for new sites within each population center. - Prepare a management plan for each population center. (USFWS, 1995)
- 2. Conduct research to more fully understand habitat conditions, fire frequency effects, seedling recruitment, genetic diversity among and within sites and population centers , population dynamics, and reestablishment techniques. (USFWS, 1995)
- 3. Enforce laws protecting the species and its habitat. Provisions of the Endangered Species Act of 1973, as amended, will be enforced. North Carolina regulations prohibit taking a protected species from private property without the landowner’s written permission and a State permit. However. at this time the collection of L. asperulaefolia plants ~ not the major threat to the species’ continued survival. In meeting their responsibilities under the Endangered Species Act, the military services involved have developed guidance directing certain actions with respect to listed species occurring on their bases. Implementation of these policies and directives should continue. (USFWS, 1995)
- 4. Reintroduce the species into historic habitat. In cooperation with the North Carolina Botanical Garden and the Center for Plant Conservation, plants should be propagated and a program of reintroduction should be initiated. Historic sites, such as the proposed Minnesott Ridge-Prescott Ridge Natural Area in Pamlico County, would be ideal sites for this program. Plants introduced into such an area should derive from the same population center, when possible, or from a nearby population source, unless genetic analyses indicate that inbreeding is a problem within populations. The genetic analysis will assist in determining appropriate reintroduction source material. (USFWS, 1995)
- 5. Negotiate binding management agreements. In order to ensure the survival of this species and proceed with delisting. permanent binding management agreements should be

negotiated between the Service and landowners. The North Carolina Plant Conservation Program or North Carolina Natural Heritage Program should assist the Service in monitoring these agreements. (USFWS, 1995)

- 6. Conduct public information and education activities. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to newspapers on the coastal plain and in the sandhills area. Cooperation with military bases should be sought: this would be a positive public relations opportunity for them. State agencies managing lands where L. asperulaefolia occurs should prepare/distribute brochures and offer educational hikes to sites where this would be appropriate. (USFWS, 1995)
- 7. Annually review the recovery efforts. The Service, North Carolina Plant Conservation Program. North Carolina Natural Heritage Program, and South Carolina Heritage Trust should meet annually with the managers of L. asperulaefolia sites to assess progress toward the recovery goals, review new information, assign any new sites to a new or existing population center, evaluate and coordinate programs planned for the coming year, and, if necessary, redirect monitoring or management actions. (USFWS, 1995)
- Revisit known populations that have not been visited in the past three years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the NCNHP database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; report the results of these site visits to the appropriate Heritage Program (USFWS, 2014).
- Search for additional populations in appropriate habitat (USFWS, 2014).
- Prioritize known sites for protection and identify recovery populations (USFWS, 2014).
- Protect additional populations (USFWS, 2014).
- Identify those populations that would contribute the most toward recovery (self-sustaining, protected, etc.) as recovery populations (USFWS, 2014).
- Determine which sites have management plans and how they are being implemented (USFWS, 2014).
- Develop and implement management plans for all remaining protected populations (USFWS, 2014).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2014).
- Update monitoring protocols and remind land managers about their commitment to monitoring this species on their property, continue to analyze monitoring data using PVA or other accepted methods (USFWS, 2014).
- Complete a population genetic analysis as suggested by Edwards (2007) (USFWS, 2014).
- Organize a meeting of land managers, researchers and other interested parties to discuss the long-term recovery of this species (USFWS, 2014).
- Work with NC Botanical Garden to conserve germplasm and further develop propagation and transplantation protocols (USFWS, 2014).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed in the 2014 5-Year Review remain important to the conservation and recovery of Lysimachia asperulaefolia and efforts to accomplish those actions should continue. Since the 2014 5-Year Review, progress has been made on several of the past recommendations for future actions. • Surveys have resulted in the discovery of 12 new occurrences or sub-populations that are part of two parent populations of Lysimachia asperulaefolia. (No new isolated populations have been found.) • A management plan for Lysimachia asperulaefolia and Echinacea laevigata populations at Fort Jackson Army Base in SC was completed in 2015. • Management plans for Holly Shelter Game Land and Sandhills Game Land are available online. The plan for Holly Shelter would benefit from more information about Lysimachia asperulaefolia. The Service is planning to work with the NC Wildlife Resources Commission and NCNHP to incorporate more specific information about rare plant management in future versions of these plans. • The NCPCP received a Recovery Challenge Grant which will fund preparation of a management plan for their Boiling Springs Lakes / Hog Branch Ponds Preserves. • The Service has contacted land managers at Bladen Lakes State Forest and offered to help prepare a management plan for their populations of Lysimachia asperulaefolia. The Service has encouraged land managers to develop and implement management plans by providing a template management plan. • Jessica Roach at UNCW is currently conducting research on the genetic structure of this species. • Elsa Youngsteadt and Clyde Sorenson at NCSU are conducting research on the pollination ecology of Lysimachia asperulaefolia populations at Ft. Bragg Army Base in NC. • The NC Botanical Garden completed out-plantings at Fort Bragg Army Base from 2012 to 2014. • The Service updated and simplified monitoring protocols for land managers that participated in the 2000-2012 long-term monitoring project summarized in Robinson and Buchanan (2014). The Service recommends initiating or continuing the following efforts that will contribute to the recovery of the species: • Revisit known populations that have not been visited in the past five years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the heritage program database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; and report the results of these site visits to the appropriate heritage program. • Search for additional populations in appropriate habitat. • Prioritize a list of populations that will contribute the most toward recovery (selfsustaining, protected, etc.) as recovery populations. • Work with land managers at Bladen Lakes State Forest, Boiling Springs Lakes, Holly Shelter Game Lands and Sandhills Game Lands to improve Lysimachia asperulaefolia populations. • Remind land managers about commitments to manage and monitor for this species. • Organize a meeting of land managers, researchers, and other interested parties to discuss the recovery of this species. • Work with the NC Botanical Garden to conserve germplasm and further develop propagation and best practices for transplanting and augmenting populations. • Develop a plan to augment populations to increase genetic variation and seed production. (USFWS, 2021)

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# SPECIES ACCOUNT: *Macbridea alba* (White birds-in-a-nest)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 6/8/1992; Southeast Region (R4)

**Physical Description**

This perennial herb usually has one stem (often clothed with long, multicellular hairs) which may be branched. The leaves are oblanceolate or spatulate, mostly in 6-8 pairs. White flowers are borne from May through July in compressed thyrses (dense flower cluster in which the main axis is racemose and the branches are cymose). The small clusters of white buds and flowers look like eggs and little bird heads in a nest. Each flower is bisexual, has a green calyx and a white two lipped-corolla about 2.5-3 cm long; the pistil and filaments are white, and the anthers purple basally. Each flower can produce four nutlets (small fruit similar to a nut), which are about 2-2.5 mm long, narrowly obovate in outline, and light brown (Godfrey and Wooten 1981, Godt et al. 2004). (USFWS, 2009)

**Taxonomy**

The genus Macbridea, which belongs to the mint f~mily (Lamiaceae or Labiatae), consists of only two species (Kral 1983, Godfrey and Wooten 1981). Macbridea alba Chapman was first collected about 1860 by A. W. Chapman and a friend named Gausman (Roger Sanders, then a graduate student at University of Texas, currently at Bot. Res. Inst. of Texas, in litt. 1977), and it was named by Chapman (1860). (USFWS, 1994).

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to the Florida panhandle and is still restricted to the same four counties: Bay, Gulf, Franklin, and Liberty. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Sexual and vegetative (USFWS, 2009)

**Reproduction Narrative**

<u>Adult:</u> Dr. Walker surmised that Macbridea may require regular recruitment from seed and is a poor competitor with other plants, requiring bare ground to germinate and grow (USFWS, 1994). Macbridea alba is a hermaphroditic species capable of both sexual and vegetative (via rhizomes) reproduction (Godt et al. 2004). This species is capable of both 9 outcrossing and selfing. However, selfed seeds exhibit inbreeding depression (Godt et al. 2004). Pitts-Singer et al. (2002) studied the pollinator-plant relationship at two sites located on the ANF. Twenty

inflorescences were observed for 34 hours over five days. The authors observed 70 visits of nine insect and spider species. Since only bumble bees (Bombus spp.) were large enough to make contact with the reproductive structures of the flowers, the authors concluded that bumble bees are the potential pollinators of M. alba. Thus, bumble bees are probably critical to the long-term persistence of M. alba because they provide a mechanism for ensuring seed set, and facilitate gene flow between plants and plant populations (Negrón-Ortiz, pers. interpretation) (USFWS, 2009).

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits grassy vegetation on poorly drained, infertile sandy peat soils of the Florida Gulf coastal lowlands near the mouth of the Apalachicola River. Also in seepage bogs and savannas and, sparingly, on drier sites with longleaf pine and runner oaks. (Based on Ward 1979.) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: The authors observed in the field that seeds germinated while in the infructescences (the fruiting stage of the inflorescence), suggesting that the matured ovules lack dormancy, in addition to the possibility of viviparous seedlings. About 87% of dry-stored seeds were viable (or germinable) for six months after dispersal, but viability of dry-stored and of buried seeds was insignificant after one year. They concluded that a persistent seed bank is not present, based on the lack of emergence of seedlings from soil that was field collected prior to seed dispersal. This lack of seed dormancy and seed bank means that if the established individuals are eliminated, a population cannot re-establish itself (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Number of Populations:**

21 - 80 (NatureServe, 2015)

**Population Size:**

1000 - 10,000 individuals (NatureServe, 2015)

**Population Narrative:**

Plant tolerates some disturbance due to forestry operations although actual effects and population numbers unknown. Substantial areas within the small range of this plant have were converted to short rotation pine plantations during the 20th century. Decline of 30-50% Many occurrences have shown fluctuating numbers from year to year (EO data in the NatureServe central database as of April 2012). 33 occurrences verified since 1989, but some of these are sub-occurrences which are clustered into larger occurrences (EO data in the NatureServe central database as of April 2012) (NatureServe, 2015). Moderate redundancy, resiliency and representation are inferred based on the number of known populations and individuals as well as the relatively large geographic distribution of the species.

***Threats and Stressors***

**Stressor:** Logging (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The timber industry in North Florida became well established in the 1850s (FNAI 2005). It started in Franklin County in the 1870s and continued to be a prominent industry until the mid-1990s (Howell and Hartsell 1995). The St. Joe Paper Company had close to a million acres in timber in the eastern region of the panhandle. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999; therefore, this industry is no longer considered a primary threat (USFWS, 2009).

**Stressor:** Urban development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Urban development continues to threaten white birds-in-a-nest. The St. Joe Company owns extensive areas of land in Northwest Florida, and focuses on commercial and residential development along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (http://www.1000friendsofflorida.org/PUBS/2060/01-Northwest-Florida). According to the study, much of the new development will be focused along roadways. Many M. alba's locations are found along US 98 and other state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, road widening and new roads continue to pose a threat to the species from habitat loss (USFWS, 2009).

**Stressor:** Fire suppression (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Suppression of fire during the dormant season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Thus, fire

suppression continues to be a threat to M. alba. Lack of fire, and subsequent growth of shrubs (particularly encroachment of Cyrilla racemiflora L., commonly known as swamp titi) and saplings in the understory, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008). Declining fire frequency reduces M. alba abundance in areas where it was previously observed in great quantities (FNAI 2008). In recently burned areas, however, plant emergence is prolific within two years of the fire event (F. Winters, 2008, pers. comm.). The ANF utilizes a 3-5 yr interval burn rotation. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., 4-5 yr intervals, are needed to maintain optimal M. alba populations (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of individual plants/Loss of habitat
**Narrative:** Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on nonfederal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. Several populations of M. alba occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. Neither section of the Act provides protection for plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. Macbridea alba is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (http://www.virtualherbarium.org/EPAC). Bay County code of ordinance (chapter 19-Environmental Standards), under sections 1907 and 1909, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (http://www.municode.com/Resources/gateway.asp?pid=14281&sid=9). Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, reconstruction, or maintenance projects) affecting protected species, then the Service can request a consultation with the Florida Department of Transportation under the Act (M. Mittiga, 2009, pers. comm.). In the Apalachicola National Forest SR 65 ROW, it should conform to specifications and coordination between Talquin Eletric, FDOT and the Service. Currently, these protections are inadequate; see section IV, action 1 (USFWS, 2009).

**Stressor:** Herbicide (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Herbicide. While the Recovery Plan (Service 1994) mentioned that the use of herbicide or the wrong type of herbicide is a threat when it is used to control vegetation on power line rights-ofways, we no longer consider this a threat to M. alba because mowing is now the common practice to maintain transmission rights-of-ways in Florida. As discussed above, herbicide treatments along transportation rights-of-ways are still a threat to the species. Franklin County allows only “spot treatment” due to impacts concerning the Apalachicola National Forest and waters within Apalachicola Bay and River basin (USFWS, 2024).

**Stressor:** Climate Change - Catastrophic events (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate Change - Catastrophic events. As discussed above under Factor A, sea level rise may pose a significant threat to some occurrences. Hurricanes have impacted the Florida Panhandle and are expected to increase in intensity and reach major category strength as warming of the land and ocean continued. Therefore, this threat is expected to continue. According to pre/postHurricane Michael analyses by C. Anderson et al. (2020), natural communities such as sandhills were more affected, whereas scrub, scrubby flatwoods, wet flatwoods, and coastal grasslands were found more resistant to damage. Macbridea alba occurs in mesic pine flatwoods, wet savannas, seepage slopes, and ecotones between pine flatwoods, so possibly it has some resistant to this disturbance. According to the Florida Climate Center (https://climatecenter.fsu.edu/topics/climate-change), winter precipitation in the Panhandle has increased, and is expected to experience around 30-40 more extreme heat days per year. By 2050, an increase of more than 50 days with temperatures ≥ 95°F is projected to most of Florida. So even if precipitation remains constant or increase, higher temperatures will result in an increase of soil moisture loss and more intense droughts, likely affecting the persistence M. alba plants, the quality of current habitat, and habitat suitability for reintroduction (USFWS, 2024)

***Recovery***

**Reclassification Criteria:**
Not relevant. (USFWS, 1994)

Recovery Priority Number: 8C

**Delisting Criteria:**
1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

**Recovery Actions:**
- Protect population in Apalachicola National Forest and on other public lands: At present, we have about 21 protected locations with an estimated 3,967 to 7,262 plants. (USFWS, 2009)
- Manage rights-of-way: This is an ongoing action. Macbridea alba is found scattered under the Apalachicola National Forest Utility ROW of SR 65. Protective measures have been established with Talquin Electric during annual maintenance and the upcoming pole replacement. Management for other M. alba elements of occurrences found in ROW outside SR 65 has not been initiated (USFWS, 2009).

- Protect and manage these plants outside Apalachicola National Forest: 3.1. Secure protection, Develop and implement management and monitoring plans for protected sites. (USFWS, 2009)
- Systematics and other studies: Genetic structure of M. alba, and Comparison of M. alba and M. carolinensis. (USFWS, 2009)
- Garden propagation and reintroduction.  his recovery action has not been initiated. According to Schulze et al. (2002) study, an ex-situ collection of seeds is not recommended due to the lack of dormancy, and poor viability of dry-stored seeds. Although conserving this species in-situ is the best option, an ex-situ collection of established seedlings and adults is recommended (USFWS, 2009).
- 1. Manage ROW (Rights-of-Way).  Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and USFWS; a management plan should be developed and implemented (USFWS, 2009).
- 2. Establish an ex-situ collection of seedlings and adults (USFWS, 2009).
- 3. Conduct population biology studies at ANF a. Compare the demographic performance of M. alba in pinelands and road habitats i) Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in roadside populations of SR 65 and pinelands. ii) Perform germination experiments (USFWS, 2009).
- 4. Revisit and conduct inventories (e.g., the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring) on all the historical locations (USFWS, 2009).
- 5. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants (USFWS, 2009).
- 6. Implement monitoring for selected populations in Bay, Gulf, Franklin, and Liberty counties. Note: Bay (Lathrop Bayou) and Gulf (SJBP) have a monitoring program. A similar monitoring protocol should be followed, thus results can be comparable across sites. Monitoring should examine density and abundance of individuals. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since M. alba occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large, protected and managed populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. The results would help determining the smallest size at which a population can exist without facing extinction, i.e., the minimum viable population size (USFWS, 2009).
- 7. The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Estimate the levels of clonality and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices, i.e., establish a representative percentage of the total genetic variation of M. alba. Sampling should occur across the range; testing clonality could involve sampling the established monitoring plots at ANF and SJSBP. a. By understanding clonality, the Service will be able to determine what is an individual and evaluate abundance. Specifically, we will be able to 1) relate flowering stems (both vegetative and flowering) to number of individuals in a given area, and 2) infer the effect of fire on flowering stems/individuals. b. The identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations. 2. Establish an ex-situ collection of seeds, seedlings, and adults. There is an ongoing conversation among FDACS, ABG, FWS, and Univ. Illinois Urbana-Champaign to establish an ex-situ collection at the ABG. 3. Clarify limits of desiccation and cold tolerance for ex-situ seed storage recommendations. 4. Understand in-situ seed germination and seedling survival vs. the role of viviparous seed germination and offspring survival, and the implications of both reproductive strategy for M. alba. 5. Monitoring. Implement monitoring for selected populations outside of ANF: Bay, Gulf, and Franklin counties. It is recommended to set up more subplots and monitor abundance and survival of both flowering and nonflowering individuals over time, whether seedling recruitment is occurring, and the effect of mechanical site preparation and hurricane disturbances. 6. Censuses. Censuses are most critical for populations outside ANF and for EOs found without plants. Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range. A consistent and repeatable method should be employed. 7. Manage ROWs. Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and the Service and document commitment to these conservation practices in land management plans or agreements. (USFWS, 2020)

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities 1. Censuses are critical for Element Occurrences found without plants (Fig. 1). For those EOs, a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) needs to be completed across the current distribution to determine abundance, threats, and habitat suitability. A consistent and repeatable method should be employed. 2. Reintroduction. A reintroduction approach should be designed and executed with the assistance of the Service botanist for those sites where the habitat is present and still suitable. An annual monitoring is required to examine plant survival and reintroduction success. For consideration: a. Tate’s Hell State Forest, Franklin Co. i. Florida Native Areas Inventory Element Occurrences # 57 & 58. No plants have been observed since 2008. ii. Florida Native Areas Inventory Element Occurrence #11 along east side of CR 67, Tate’s Hell State Forest, Franklin Co. was fragmented due to rights-of-way herbicide spraying and culvert reinstallation. 3. Conduct surveys/inventories on potentially new sites (targeting recently burned sites). 4. Establish (or continue) frequent growing-season fire regimes to maintain optimal conditions of populations. Re-visit sites shortly after a burn event and count individuals. Monitoring and Research Activities 1. Monitoring. a. Implement monitoring for selected populations outside of Apalachicola National Forest in Bay, Gulf, and Franklin counties. The ABG is monitoring several documented sites in Gulf and Franklin counties (Cooperative Agreement No. # F21AC02540-00). However, it is recommended to set up more subplots and monitor abundance and survival of both flowering and nonflowering individuals over time, whether seedling recruitment is occurring, and the effect of mechanical site preparation and hurricane disturbances. b. Continue the long-term monitoring in Apalachicola National Forest sites (FNAI 2024). c. As sea levels rise, seawater intrusion increases in duration, frequency, and spatial extent. To assess the effect of salinity on M. alba, sites where intrusion of salt water occurs (or will occur) should be considered for long-term monitoring. 2. Manage Rights-of-Ways. Continue fostering conservation practices for utility and transporation rights-of-ways with the Forest Service, Talquin Electric, the Department of Transportation, and the Service and document commitment to these conservation practices in land management plans or agreements. 3. Ex-situ seed studies. Since there is a possibility that seeds in long-term storage are unlikely to remain viable, examining their viability is recommended using multiple methods (USFWS, 2024).

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# SPECIES ACCOUNT: *Malacothrix indecora* (Santa Cruz Island malacothrix)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An annual herb with broadly lobed, fleshy leaves. Produces hemispheric heads, 2-6 mm wide, of yellowish-green flowers. The heads are surrounded by long bracts. Blooms April-September. (NatureServe, 2015)

**Taxonomy**

Malacothrix indecora was first described by Edward Lee Greene (1886), based on specimens collected from “islets close to the northern shore of Santa Cruz Island.” In 1957, Williams published a combination of the species as Malacothrix foliosa var. indecora (Ferris 1960) and subsequently Munz (1974) later synonymized the taxon with Malacothrix foliosa. However, Ferris (1960) and others (Smith 1976, Davis 1980) continued to recognize the taxon as Malacothrix indecora and this nomenclature has been retained in the most recent treatments of the genus (Davis 1993, Jepson 2010, Flora of North America (FNA) 2010a). There have been no changes in the taxonomic classification or nomenclature since the time of listing (USFWS, 2010).

**Historical Range**

See current range/distribution.

**Current Range**

Known from three of the northern Channel Islands (Santa Cruz Island, San Miguel Island, and Prince Island) in Santa Barbara County, California. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Little is known about the life history ofSanta Cruz Island malacothrix. This annual species is poorly to moderately selfcompatible (Davis 1998) (USFWS, 2000).

**Habitat Type**

Adult: Coastal bluffs and flats (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

<u>Adult:</u> Low (inferred from NatureServe, 2015)

**Site Fidelity**

<u>Adult:</u> High (inferred from NatureServe, 2015)

**Habitat Narrative**

<u>Adult:</u> The species generally occurs on coastal bluffs and slopes, often on midden sites, at elevations of less than 20 meters (65 feet). The species occurs on Santa Cruz Island, Santa Rosa Island, and San Miguel Island, Santa Barbara County, California. The islands are part of Channel Islands National Park (CINP). Most of Santa Cruz Island (76%) is private property of The Nature Conservancy, CINP owns the rest of Santa Cruz Island and all of Santa Rosa Island, and San Miguel Island is owned by the Navy but is administered by CINP. Both CINP and TNC lands are managed for natural resource conservation (USFWS, 2022).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

<u>Adult:</u> No information found

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

3 extant (USFWS, 2022)

**Population Narrative:**

The status of both Malacothrix indecora and M. squalida has not changed substantially since the time of listing in 1997. Currently, there are eight known populations of M. indecora, which occur on four of the northern Channel Islands: Anacapa, San Miguel, Santa Rosa, and Santa Cruz. These populations have exhibited some decline in the number of individuals over the last 15 years and we are lacking recent or comprehensive survey data for all of the populations, which makes it difficult to draw any conclusions about the current abundance trend for this species. There are three locations of M. indecora that were recently discovered in the spring of 2010 on East Anacapa Island where large patches of iceplant were removed in 2009. These new discoveries appear to indicate that this species might be expanding its range, since it was not historically known from Anacapa Island. There are two known extant populations of M. squalida, which occur on two of the northern Channel Islands: Santa Cruz and Anacapa. These populations have exhibited some decline and overall fluctuation in numbers of individuals over the last 15 years, but the number of individuals of this species is already very low and we do not have any recent or comprehensive survey data, which makes it difficult to draw any conclusions about the current abundance trend for this species (USFWS, 2011).  Distribution: The distribution of Santa Cruz Island malacothrix has not changed since the last 5- year review (Service 2010). There are at three extant and one historical occurrences on Santa Cruz Island, one extant occurrence on Santa Rosa Island, and two presumed extant occurrences on San Miguel Island (Table 2). The San Miguel Island occurrences have not been visited in more than 20 years; whether they remain extant is unknown. Santa Cruz Island malacothrix, contrary to information in the last 5-

year review, is not known to occur on Anacapa Island (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Fire and Invasive Species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** we still believe that non-native plant species and catastrophic fires pose a risk to both the Malacothrix species. With the removal of non-native herbivores, we have also seen an increase in vegetation biomass, thus increasing the chance of larger and more frequent fires. Particularly, the vegetative biomass of non-native species has increased, due to the removal of non-native herbivores and continued exposure, thus increasing the amount of competition for resources for both Malacothrix species. There has been some speculation that climate change may further complicate these two issues; however we lack adequate information to draw any conclusions about the specific changes that may occur on the northern Channel Islands as a result of climate change (please see discussion under Climate Change below) (USFWS, 2010).

**Stressor:** Hybridization (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Extirpation
**Narrative:** Malacothrix indecora and M. squalida hybridize both with one another and with several other Malacothrix species (McEachern, in litt. 2010). In particular, there is one documented occurrence of M. indecora and M. squalida hybrids in a north-draining canyon at Potato Harbor on Santa Cruz Island (McEachern, in litt. 2010). There are two other Malacothrix species that occur on the same islands as M. indecora, but M. indecora is the only other Malacothrix species that co-occurs with M. squalida (Junak et al. 1995). Hybridization was not addressed in the listing rule or the recovery plan and we lack any specific data which would allow us to draw any conclusions about how hybridization may affect either of these species at this time (USFWS, 2010).

**Stressor:** Stochastic Extinction (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Extirpation
**Narrative:** At the time of listing, we noted that due to the limited geographic range, and limited number of individuals and populations of both Malacothrix indecora and M. squalida, these species were at risk of stochastic extinction resulting from loss of genetic diversity, through chance events affecting survival and reproduction, and through naturally occurring catastrophic events, such as fire, drought, disease, or storms (Service 1997). We believe that the existence of only two and eight relatively isolated populations of M. squalida and M. indecora, respectively, place these species at risk of extinction from stochastic events. Because both species have a relatively limited geographic range and exist as only a few populations, the genetic viability and resilience of both M. indecora and M. squalida to human-caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). Studies on Santa Cruz Island have shown that unexpected, complex interactions sometimes result in substantial declines within endemic species populations that were assumed to be stable (Roemer et al. 2001). The

conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (Shaffer 1981, Groom et al. 2006, Primack 2006). In particular, although the plants are apparently self-compatible, the small size of the populations make it difficult for these species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species (USFWS, 2010).

**Stressor:** Climate Change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Because all of the populations for both Malacothrix species occur on coastal bluffs in close proximity to the ocean, these species are subject to a wide range of climatic conditions, such as occasional salt spray (Wilken 1996), which may directly affect the soils and plants at low elevation exposed coastal flats. Sea level rise and the continued erosion of the ocean-front cliffs on the exposed bluffs of the northern Channel Islands from high surf and storm events, in addition to climate variability, both from year to year and due to large-scale climate change, pose a threat to the relatively small and exposed Malacothrix populations (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
1. Maintain existing stable populations on San Miguel, Santa Cruz, and Santa Rosa Islands for a period of 15 years that includes the normal precipitation cycle (USFWS, 2022).

2. Seed stored in CPC cooperating facilities (USFWS, 2022).

3. Seed germination and propagation techniques understood (USFWS, 2022).

4. Successful outplanting techniques developed (USFWS, 2022)

5. Life history research conducted (USFWS, 2022)

6. Weed management plan developed and implemented (USFWS, 2022).

7. If declining, determine cause and reverse trend (USFWS, 2022)

Recovery Priority Number: 8

**Delisting Criteria:**
1. No decline after downlisting for 10 years (USFWS, 2022).

2. All potential habitat surveyed (USFWS, 2022).

**Recovery Actions:**
- Reclassification criteria: This criterion is relevant; however, it should be updated to include a more measurable and threats-based component. Additionally, it may become increasingly difficult to evaluate the population over 15 years that includes the normal precipitation

cycle due to the fact that the normal precipitation cycle is already changing and is predicted to continue to fluctuate considerably under the effects of climate change (IPCC 2007). This criterion does not include a clear definition of what constitutes a stable population for this species; therefore, it should be updated to include a more concrete definition of this term. David Keith presents a widely accepted method of evaluation of at-risk plant species that is based on The World Conservation Union (IUCN) Red List Criteria of 1994, consisting of a set a decision rules based on quantitative thresholds of population size, distributional range, rates of decline, and extinction risk (Keith 1997). We recommend that the recovery criteria for Malacothrix indecora be updated to include a more well-defined method, such as the one presented by Keith (1997), for assessing when this species can be considered stable and recovered. Despite the three new occurrences of Malacothrix indecora that were discovered this year, the most recent surveys of the M. indecora populations seem to show that overall, the number of individuals has decreased somewhat since listing (McEachern, in litt. 2010). Additionally, the precipitation cycles during the last 15 years have not been normal (Levine et al. 2009, Levine et al. 2010); therefore, this criterion has not been met (USFWS, 2010). Delisting criteria: This criterion is relevant; however it is rather vague. We recommend that this criterion be revised to take into consideration that there may be some fluctuation in the population sizes of these annual plant species; however, delisting may be considered when this species is considered recovered based on the quantitative methods of evaluation presented by Keith (1997) or some other comparable method. This criterion has not yet been met (USFWS, 2010).

- Develop and implement monitoring and adaptive management plans for all of the existing populations. Monitoring should occur at intervals of 1 to 2 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 1a. Work closely with agencies such as TNC, USGS, and NPS to continue monitoring efforts for the species and to develop a long-term adaptive management plan for special status species which occur on the northern Channel Islands (USFWS, 2010).
- Develop and implement an integrated non-native plant control program for Santa Cruz, Anacapa, San Miguel, and Santa Rosa Islands, which complements and enhances existing efforts (USFWS, 2010).
- 3. Continue to research the species' life history requirements, especially with regard to the habitat conditions favorable to both species. 3a. Specifically, we recommend a follow-up study to evaluate the response of both Malacothrix species to the removal of the non-native mammals from Santa Cruz, Santa Rosa, and San Miguel Islands and whether recovery of the soil health and stability has occurred. Because non-native large herbivores still remain on Santa Rosa Island, some baseline data could be gathered now and compared with the results that are gathered several years after the eventual removal of the remainder of these animals (USFWS, 2010).
- Update the recovery criteria for both Malacothrix indecora and M. squalida to include a more measurable and threats-based evaluation method, based on the recommendations presented in the discussion of the recovery criteria for both species on pages 16 through 18 of this review (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Survey San Miguel Island occurrences to verify their continued persistence. 2. Establish regular monitoring for known natural populations of Santa Cruz Island malacothrix on Santa Cruz, Santa Rosa, and San Miguel Islands. 3. Enhance existing natural populations on Santa Cruz Island. 4. Establish new recovery populations on Santa Cruz Island. 5.

Improve the completeness of coverage over years for Santa Cruz Island malacothrix in conservation seed banks, for both Santa Cruz and San Miguel Islands. 6. Survey additional potential habitat on Santa Cruz and San Miguel Islands. 7. Restrict public access to the Lobo Canyon-Cow Canyon population during the Santa Cruz Island malacothrix growing season (USFWS, 2022).

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# SPECIES ACCOUNT: *Manihot walkerae* (Walker's manioc)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/02/1991; Southwest Region (Region 2) (USFWS, 2016)

**Physical Description**

A perennial herb, highly branched or few-stemmed, sprawing or erect, up to 1.5 m tall. The stems are smooth, grayish-brown, 3.2 millimeters (0.13 inch) in diameter. The leaves are alternate, deeply incised, and palmately 5-lobed. Flowers are unisexual and occur in racemes with staminate flowers in the raceme opening later than pistillate ones. Staminate flowers are tubular, constricted in the middle; tepals are 1.2 centimeters (0.47 inch) long, light purplish streaked externally, and cleft one-fourth of the way down into 5 lobes; stamens are 6-10, filaments and anthers are cream-colored. Flowers from spring through autumn, probably following rains. Clusters of 2-3 fragrant, white flowers open in late afternoon and last only 1 day. There are separate male and female flowers on the same plant. (USFWS, 1993; NatureServe, 2015)

**Taxonomy**

Leon Croizat (1942) described Walker's manioc as a distinct species. Rogers and Appan (1973) place it within section Parvibracteatae of the genus Manihot. Its closest relative may be M. subspicata, another rare plant of south Texas and northeast Mexico found on caliche or rocky limestone substrates. Tom Patterson observed that the ranges of these two species overlap in the Loreto sand plain of Tamaulipas (Patterson 2008, pers. com.). (USFWS, 2009)

**Historical Range**

Walker's manioc is known only from the Lower Rio Grande Valley of Texas (Hidalgo and Starr counties) and northern Tamaulipas, Mexico. One historical location for Walker's manioc was Ringgold Barracks, an old fort located on the eastern outskirts of Rio Grande City, Starr County, Texas. (USFWS, 1993)

**Current Range**

Walker's manioc is known only from the Lower Rio Grande Valley of Texas (Hidalgo and Starr counties) and northern Tamaulipas, Mexico. (USFWS, 1993). As of 2019: Walker's manioc has been documented from as far north as Duval County in southern Texas (TXNDD 2018, p. 18) to the vicinity of Aldama (Service 2009, p. 11) in the most southern part of the state of Tamaulipas, Mexico; a distance of approximately 532 kilometers (km). (USFWS, 2019).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual and asexual (USFWS, 2009)

**Breeding Season**

Adult: Spring through fall (USFWS, 2009)

**Reproduction Narrative**

Adult: The species is self-fertile, and does not appear to require a rare or specialized pollinator (Best 2008). Flowers from spring through autumn, probably following rains. The fruit capsules contain up to three seeds, which are dispersed a distance of several meters by the spontaneous, violent dehiscence (rupturing) of the capsules upon drying, which impedes seed collection (Best 2008). Seeds may remain dormant for a year or more, but germination can be induced by exposure to heat and moisture (Simpson 1995), or gibberellic acid (a naturally occurring plant hormone) (Best 2008). Individual plants have produced up to 20 rounded tubers 2 to 3 inches (5 to 7.5 cm) in diameter, after about 3 years' growth (Best 2008). This demonstrates that the species perenniates in the wild through both seeds and tubers (Best 2008). (USFWS, 2009). Walker's manioc is capable of dormancy due to its underground tubers that remain viable even when unfavorable aboveground conditions (e.g., drought, extended period of high temperatures, freezes) result in leaves and stems dying back. The ability of the species to regenerate, or to spread to new sites, via pieces of tuber has positive implications for propagation and reintroduction recovery actions. Observations at Lower Rio Grande Valley National Wildlife Refuge (LRGV NWR) show that manioc plants can begin tuber production at less than one year of age (Best 2008 in Service 2009, p. 10) and that potted manioc plants can produce numerous, large tubers by 2.5 years. Field observations indicate that javelina (Pecari tajacu) dig up and consume tubers, but may also act as agents of dispersal by dropping tuber pieces as they move (Service 2009, p. 18). In Tamaulipas, Mexico, manioc grew from tuber pieces scattered about in a crop field (Best 2008 in Service 2009, p. 16). Tubers appear to help the species survive adverse environmental conditions as well as anthropogenic surface impacts including herbicides, mowing, and perhaps disking or plowing. Manioc has reemerged following herbicide application that killed the aboveground portions of the plants (Best 2008 and Patterson 2008 pers comm. in Service 2009, p. 10). (USFWS, 2019).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Widely-spaced or small clusters (USFWS, 2009)

**Environmental Specificity**

Adult: Moderate, with some key requirements (USFWS, 2009)

**Habitat Narrative**

Adult: The recorded habitat descriptions from collections of the species vary from native brush to grassland. Endemic to the Tamaulipan grassland-thornscrub community of the Lower Rio Grande Valley, where it occurs on sandy-loam soils underlain by caliche. Walker's manioc plants occupy only a small portion of the upland vegetation of the Goliad geological formation, in shallow, calcareous sandy soil overlying indurated caliche. The soil depth is often 12 in (30 cm) or less. Populations may consist of widely-spaced individual plants along bands of shallow soil, or small clusters of a few dozen individuals. Johnston (1963), Best (1995, 2005), and Poole et al. (2007) have described plant species found in close association with Walker's manioc. These include short native grasses and herbaceous plants, and low shrubs and sub-shrubs. (USFWS, 2009; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2009)

**Dispersal/Migration Narrative**

Adult: The fruit capsules contain up to three seeds, which are dispersed a distance of several meters by the spontaneous, violent dehiscence (rupturing) of the capsules upon drying, which impedes seed collection (Best 2008). (USFWS, 2009)

***Population Information and Trends***

**Population Trends:**

Not available.

**Number of Populations:**

3 (USFWS, 2009). Update: 11 (USFWS, 2019).

**Population Size:**

<1,000 individuals (NatureServe, 2015)

**Population Narrative:**

A regional endemic of southern Texas and northern Mexico, this species was thought to have been extirpated from the U.S. until a single surviving plant was discovered in 1990. Three sites on LRGV NWR, consisting of up to 90 individuals each, may be large enough to be considered viable populations. Five additional sites found in Texas have as many as 30 individuals. There is probably less than 1,000 individuals. (USFWS, 2009; NatureServe, 2015). With the exception of the Duval County population, all known Texas manioc populations occur in western Hidalgo County and southeastern-to-southcentral Starr County with the majority of these populations located within 2.4 km of the Rio Grande. Although the population data show a patchy, scattered distribution, much of the potential habitat between known populations has not been surveyed. The discovery of additional sites in 2009 illustrate the likelihood of finding more populations in unsurveyed suitable habitat on which the land cover has not been mined or otherwise built over. Three of the largest Texas populations occur on protected tracts of the LRGV NWR (TXNDD 2018, pp. 6, 8, and 10; Best 1996 in Service 2009), which implements monitoring and management actions intermittently. All other populations in Texas and Mexico, except for a small site on TXDOT ROW, are on privately-owned land. The TXDOT site in Hidalgo County is considered highly vulnerable because of its location along a road (D. Price 2007, pers. comm.). (USFWS, 2019).

***Threats and Stressors***

**Stressor:** Urban and residential development (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Urban and residential development continues at a rapid pace throughout the border region of south Texas and northern Mexico. The human populations of Starr and Hidalgo Counties are projected to grow 67% and 88%, respectively, between 2000 and 2025 (Texas State Data Center 2008). Habitat loss is likely to continue both through development of sites as well as increased surface mining of caliche for construction of roads and parking lots. (USFWS, 2009)

**Stressor:** Energy development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Intensive energy exploration continues throughout the entire range of Walker's manioc in south Texas and northeast Mexico. Under Texas and Mexican law, mineral rights owners take precedence over surface owners. Seismic exploration, pipelines, oil and gas wells, and access roads have proliferated on private lands as well as tracts of LRGV NWR, incrementally augmenting the loss of potential habitat of this and other listed plant and animal species. Habitats and populations at LRGV NWR are potentially vulnerable to impacts from oil and gas exploration, since USFWS does not own the mineral rights pertaining to most of the refuge's tracts. (USFWS, 2009). 2019 update: At the end of 2018, there were no wind turbines, oil and gas well pads, or roads directly impacting known manioc populations. However, the two south central Starr County manioc population sites were within 4.0 km and 4.8 km from existing turbines at large wind farms to the east and north, respectively. A 56–100-turbine wind farm is proposed for construction to the northwest of these populations. In Starr and Hidalgo counties, there are five existing wind farms (USGS 2019, unpaginated) with some of the 380 turbines atop manioc-appropriate soils. Wind energy development does not have a federal nexus and is not required to carry out surveys for listed species, therefore placement of turbine pads and internal roads could impact undiscovered populations, but the level of impacts is unknown. (USFWS, 2019).

**Stressor:** Habitat loss (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threats to Walker's manioc are habitat loss and competition from invasive grasses. Although the caliche outcrops where the species occurs are not conducive to production of row crops, extensive surface mining of caliche supplies much of the base material for highways, unpaved roads, well-drilling pads, and parking lots throughout the region. Surface mining of caliche is therefore a major threat to species, such as Walker's manioc, that are endemic to exposed caliche outcrops. (USFWS, 2009)

**Stressor:** Invasive plants (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Many species of Old World grasses have been introduced in the Tamaulipan region of south Texas and northeast Mexico for cattle forage and erosion control, including several that

are now highly invasive (Best, in press). The “common variety” of buffelgrass (Pennisetum ciliare) was derived from a single apomictic individual from northern Kenya (Holt 1985). Common buffelgrass was introduced in south Texas beginning in 1946 and is now abundant from Texas and Tamaulipas to Arizona and Sonora. Buffelgrass is well adapted to the welldrained calcareous soils where Walker’s manioc occurs. This forage grass is typically established by root-plowing sites with powerful tracked vehicles, then broadcasting the seed in the disturbed soil. A large amount of potentially suitable habitat for Walker’s manioc has been converted to root-plowed buffelgrass pasture. Buffelgrass often increases following soil disturbance, allowing it to spread rapidly along road, powerline, and pipeline rights-of-way. It is present at most Walker’s manioc sites, frequently dominating the herbaceous vegetation and suppressing most native species including Walker’s manioc. In the Loreto sand plain another introduced grass, pitted bluestem (Bothriochloa pertusa), may also compete with Walker’s manioc (Best 2005). (USFWS, 2009)

**Stressor:** Genetic swamping (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A closely related plant, cassava (Manihot esculenta), is an important staple crop throughout the tropics. Walker’s manioc may serve as a source of genetic material for the development of improved cassava cultivars (U.S. Fish and Wildlife Service 1990b, 1993a). The storage life of edible cassava roots is significantly diminished by post-harvest physiological deterioration (PPD). Researchers created an inter-specific hybrid between cassava and propagated specimens of a Mexican collection of M. walkerae which is the only known source of resistance to PPD (Centro Internacional de Agricultura Tropical 2005; Cuambe 2007). This research has not directly affected wild populations, since the source material came from cultivated plants. However, if the inter-specific hybrid or cultivars derived from it are able to back-cross with wild plants, this could threaten wild populations through genetic swamping. (USFWS, 2009)

**Stressor:** Predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In September 2003, Tom Patterson reported an incidence of digging in the exact locations of Walker’s manioc plants on three tracts of LRGV NWR (Patterson 2003, pers. com.). These plants had been precisely mapped with GPS, and had been identified with numbered aluminum tags. A refuge law enforcement officer (who is a skilled tracker) and the plant ecologist investigated these sites. They determined that the digging had not been done by humans and identified numerous tracks of javelina (collared peckary) at these sites. Javelina feed heavily on plant seeds and tubers (Leopold 1972). The refuge staff observed that some partially-eaten tuber fragments had sprouted new roots and shoots (Best 2008). Feral hogs are abundant in the region, and may also constitute a serious threat to Walker’s manioc populations (Patterson 2008, pers. com.). Patterson also observed rabbits consuming the stems and leaves of Walker’s manioc (Patterson 1996, pers. com.). (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** According to the Intergovernmental Panel on Climate Change (IPCC) (2007) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007). It is very likely that over the past 50 years cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007, p. 1). Some climate change models also predict increased precipitation along the Gulf Coast, largely due to increased tropical storm activity and severity (Twilley et. al. 2001). Since the species now occurs in some of the most xeric of regional habitats, increasing rainfall could reduce its competitive advantage in those marginal sites. Regardless of how changes in temperature and rainfall amounts and patterns may affect the autecology of Walker's manioc, the altered synecology may be far more significant. For example, higher winter temperatures and increased precipitation could augment competition from buffelgrass or other introduced invasive grasses. Conversely, the same changes could expand the range or increase the pathogenicity of Pyricularia grisea, a rust fungus that attacks buffelgrass, thereby reducing its invasiveness. The possible effects of climate change on the synecology of Walker's manioc habitat are infinitely complex. Therefore, the Service will continue to monitor the species and its habitat, and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2009)

**Stressor:** Quarrying/Mining (USFWS, 2019).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Google Earth imagery dated January 2017 shows numerous pits or caliche quarries in the area between the most eastern manioc population in southern Texas and Rio Grande City, Texas. Mining is evident on this imagery to both the north and south of Highway 83 with ongoing activity at a number of the sites as evidenced by on-site vehicles. Expansion of a number of these pits can be confirmed by comparing imagery across years. All of the manioc sites in Hidalgo and Starr counties, including some on refuge tracts, are in relatively close proximity to either active quarries or what appear to be old pits that are now full of water, illustrating that the species occurs within a zone of active caliche or gravel quarrying. On private land, known populations are not currently protected by agreements and any undiscovered populations that may exist remain threatened by caliche mining. (USFWS, 2019).

**Stressor:** U.S./Mexico Border development (USFWS, 2019).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Walker's manioc's proximity to the Rio Grande and to HWY 83 increases the vulnerability of the species to development which tends to occur along the river and HWY 83. Proximity to the Rio Grande also means more vulnerability to new roads, new border barriers, increased traffic, and other activities related to increased law enforcement and border security. (USFWS, 2019).

***Recovery***

**Reclassification Criteria:**
Maintain or establish 15 self-sustaining populations of Walker's manioc in the United States. Establish management plans (public lands) or management agreements (private lands) to insure the protection of these populations. (USFWS, 1993)

2019 Downlisting Criterion amendment: Within the Hidalgo-Starr Counties, Texas Recovery Unit, establish or maintain 15 distinct, self-sustaining populations of Walker's manioc. Each population should consist of at least 1,000 reproductive individuals. (USFWS, 2019).

Recovery Priority Number: 8C

**Delisting Criteria:**
1. Over a 30-year period, maintain at least 15 fully protected, self-sustaining populations containing at least 1,000 reproductive individuals in each, within the known U.S. range. (USFWS, 2019).

Protection and management agreements need to be perpetual to provide a permanent level of protection. (USFWS, 2019).

**Recovery Actions:**
- Protect the habitat of the existing populations on private lands in the United States and Mexico. (USFWS, 1993)
- Gather biological information necessary for management and develop a monitoring program for populations. (USFWS, 1993)
- Search for new populations in the United States and Mexico. (USFWS, 1993)
- Establish a botanical garden population. (USFWS, 1993)
- Initiate a reintroduction program into suitable habitat on the Lower Rio Grande Valley National Wildlife Refuge, Texas Parks and Wildlife Department lands and other lands made available for use. (USFWS, 1993)
- In 2019, one Recovery Unit was identified: Recovery Unit 1 – Hidalgo-Starr Counties, Texas. (USFWS, 2019).
- Criterion 1 calls for establishment or maintenance of at least 15 self-sustaining populations of 100 or more individuals. This criterion should be revised using updated methods to describe what constitutes a viable population, and the number and geographic distribution of populations necessary for recovery. (USFWS, 2009)
- Criterion 2 requires establishment of "agreements for the protection and management of all populations on private lands..." However, USFWS has no authority to require private landowners to protect endangered plants. Furthermore, because the USFWS cannot survey private lands without the owner's permission, it is not possible to quantify the number of populations requiring protection. The criterion, as currently written, tends to promulgate misinterpretation of the authority of the Endangered Species Act, and might discourage landowners from cooperating with USFWS in the conservation of this species. Finally, successful recovery may be possible without protecting all known sites. This criterion should be revised to establish quantifiable, attainable objectives. (USFWS, 2009)

- The plan should have a recovery criterion that addresses seed banking, establishment of refugium populations and reintroduction efforts, all of which serve as safeguards against the unavoidable loss of populations to development, competition from invasive species, or catastrophic events. (USFWS, 2009)
- Periodic monitoring and surveys of known sites in Texas and Tamaulipas. In particular, a quantitative survey should be conducted at the three sites on LRGV NWR to detect population trends at those sites. (USFWS, 2009)
- Additional surveys of potential habitat in Texas and Tamaulipas, focusing on sites with Goliad-formation caliche outcrops that have not previously been surveyed. (USFWS, 2009)
- Seed collection for propagation and seed banking, establishment of seed increase plots, and pilot reintroduction projects. (USFWS, 2009)
- In-situ investigation of reproductive biology and population dynamics. (USFWS, 2009)
- Investigation of the genetic structure of known populations throughout the species range. (USFWS, 2009)
- Establish cooperative efforts to promote the conservation of Goliad formation caliche outcrops. (USFWS, 2009)
- Promote cooperative efforts with Mexican agencies, scientists, and non-profit conservation organizations to conserve populations in Mexico. (USFWS, 2009)
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. (USFWS, 2009)
- Determine whether inter-specific hybrids of M. esculenta and M. walkerae, or cultivars derived from those hybrids, are able to create fertile progeny with wild M. walkerae. (USFWS, 2009)

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# SPECIES ACCOUNT: *Marshallia mohrii* (Mohr's Barbara's buttons)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/7/1988; Southeast Region (R4)

**Physical Description**

Erect perennial herb, 3 to 7 decimeters (1 to 2.3 feet) tall. The leaves are alternate, 8 to 20 centimeters (cm) (3.2 to 7.8 inches) long, firm-textured, three-nerved, and lanceolate-ovate in shape. Leaves are often clustered near the base and gradually reduce in size upwards. The flowers are typically produced in several heads in a branched arrangement. The heads are approximately 2.5 cm (1 inch) broad and consist of disk flowers (tubular in shape) which are pale pink or white in color. The fruit is an achene (USFWS, 1991).

**Taxonomy**

In the sunflower family (Asteraceae) (USFWS, 1991). The taxon is currently recognized as valid by the Integrated Taxonomic Information System (ITIS) (ITIS 2015), as well as national and regional floras (e.g., Flora of North America [Watson 2006] and Flora of the Southern and Mid-Atlantic States [Weakley 2015]). While the taxonomic status of this species is not affected, some authors use the alternate common name Coosa Barbara’s-buttons (e.g., Noss 2012, Spaulding 2013, Weakley 2015) rather than Mohr’s Barbara’s buttons used by the Service and others (e.g., Chafin 2007, ITIS 2015, NatureServe 2015). (USFWS, 2016)

**Historical Range**

Historical records exist for Walker County, Georgia, and Walker and Cullman Counties, Alabama, in addition to the current range (USFWS, 1991).

**Current Range**

Currently known from Bibb, Cherokee, and Etowah Counties, Alabama, and Floyd County, Georgia (USFWS, 1991)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Abiotic, Insect (EPA, 2016)

**Breeding Season**

Adult: Flowering in mid-June; fruiting in July to August (EPA, 2016)

**Key Resources Needed for Breeding**

Adult: Insects for pollination (EPA, 2016)

**Reproduction Narrative**

Adult: Mohr’s Barbara’s button flowers mid-May to June (Patrick et al. 1995). Flowers are pollinated by beetles, butterflies, and other small insects and must be cross-pollinated to set viable fruit (USFWS, 2019).

**Habitat Type**

Adult: Wetland, Terrestrial (NatureServe, 2015b)

**Habitat Vegetation or Surface Water Classification**

Adult: Barrens, forest edges, meadows, grasslands (NatureServe, 2015b)

**Dependencies on Specific Environmental Elements**

Adult: sandy clays, which are alkaline, high in organic matter, and seasonally wet (USFWS, 1991)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015b)

**Habitat Narrative**

Adult: The habitat is moist prairie-like openings in woodlands, along shale-bedded streams, and meadows. The soils are sandy clays, which are alkaline, high in organic matter, and seasonally wet. Most currently known populations occur on soils of the Conasauga-Firestone Association. Plants occur in full sun or partial shade in a grass-sedge community (USFWS, 1991; NatureServe, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds are probably dispersed by birds and other small mammals (USFWS, 2019).

***Population Information and Trends***

**Population Trends:**

Not available.

**Number of Populations:**

19 extant (USFWS, 2022)

**Population Size:**

Up to 6,740 individuals estimated (USFWS, 2016)

**Population Narrative:**

Schotz (2014) estimated the total range-wide population to be up to 6,740 individuals. Additional recent survey data from some of these sites and other sites not visited by Schotz in Alabama (e.g., AANG 2015, TVA 2015) suggests that this estimate is low; however, 2015 surveys by Malcolm Hodges (pers. comm. 2015) did not relocate plants at three small sites in Georgia where Schotz had previously found them. Together, this recent survey data suggests that the range-wide Mohr’s Barbara’s buttons population size may approach 10,000 plants (Schotz 2014, AANG 2015, M. Hodges pers. comm. 2015, TVA 2015). Individual sites may range from fewer than 20 plants to well over 1,000 (Schotz 2014, AANG 2015, TVA 2015); although, most (27

[79%]) of the 34 extant sites surveyed by Schotz support 200 or fewer plants. Furthermore, two-thirds of the plants encountered during Schotz's surveys were found at only seven sites. Additionally, Schotz noted that at a given site, plants may be clustered in areas of approximately 50 square feet or can be scattered across several acres, which is similar to observations made by others (i.e., AANG 2015, TVA 2015). (USFWS, 2016).   19 known extant populations (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Destruction and Degradation of Habitat (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Clearing, conversion, and agricultural activities remain persistent threats to various Mohr's Barbara's buttons' occurrences (Schotz 2014). Nearly one-third (11 of 34) of extant sites Schotz (2014) surveyed have been converted to pine plantations and/or had been impacted by recent timber harvests. In addition, logging is thought to have extirpated Etowah County, Alabama's only known population (Schotz 2014, D. Spaulding pers. comm. 2015), while conversion to row crop agricultural field has likely extirpated one population in Cherokee County, Alabama (Schotz 2014). Suitable habitat for Mohr's Barbara's buttons remains vulnerable to loss. As described above, most Coosa Valley prairies are thought to have been lost since the early 1800s with the only known remnants of this habitat currently located in Floyd County, Georgia (Duncan 2013). Similarly, Bibb County, Alabama's Ketona dolomite glades are unique and exceedingly rare habitats and are vulnerable to damage by recreational uses and adjacent logging activities. Schotz (2014) noted damage to two glades by recreational traffic (e.g., ATV use) and logging damage or vulnerability of two others. Construction of a borrow pit is thought to have reduced available habitat for one site in Floyd County, Georgia (Schotz 2014). Furthermore, development and associated habitat destruction are projected to continue for decades to come throughout the southeastern United States (Stein et al. 2010), which could further encroach upon and limit habitat suitable for Mohr's Barbara's buttons.  (USFWS, 2016)

**Stressor:** Inadequate/Incompatible Habitat Management (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** An important threat to Mohr's Barbara's buttons' continued survival is incompatible and inadequate land management. While the species is apparently able to survive certain types of forestry practices (e.g., limited timber harvesting that opens up the canopy), its apparent inability to tolerate heavy shading likely increases it susceptibility to practices that promote vegetation succession and encroachment of invasive species (e.g., fire suppression). Fire may be an important mechanism for maintaining the open character of some of Mohr's Barbara's buttons habitats. Inadequate fire regimes threaten some occurrences by allowing competing vegetation—particularly hardwoods—to grow unchecked, thereby encroaching upon available habitat for Mohr's Barbara's buttons and reducing availability of resources (e.g., light) that the species requires to survive and thrive (Patrick et al. 1995, Schotz 2014). Fire exclusion was noted as a primary threat to 24% of sites surveyed by Schotz (2014), whereas succession was considered a threat to 29%. Highway and utility rights-of-way are currently home to various Mohr's Barbara's buttons sites. The known extent of three extant populations are restricted to a

TVA utility right-of-way (in Jefferson County, Alabama), whereas portions of at least six other populations occur in either utility or road rights-of-way (Allison 1993, Schotz 2014, M. Hodges pers. comm. 2015). As such, these sites are heavily dependent upon compatible management regimes to maintain healthy populations (e.g., Schotz 2014, AANG 2015, TVA 2015). Mohr's Barbara's buttons is particularly vulnerable to herbicides and incompatible mowing regimes within its habitats; however, appropriate mowing regimes may also serve as valuable conservation tools in these areas (Schotz 2014). Schotz (2014) noted that nearly one-third of all sites surveyed were vulnerable to incompatible management regimes within rights-of-way throughout the species' range. Furthermore, at least one site along a road right-of-way in Cherokee County, Alabama is thought to have been extirpated by incompatible management (Schotz 2014). Additional emphasis on reintroducing fire or fire surrogates (e.g., mowing) is needed to promote healthy populations and maintain open conditions that this species requires. (USFWS, 2016)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mohr's Barbara's buttons is a State threatened plant in Georgia (Patrick et al. 1995) and, therefore, receives State protection from non-permitted collection and sale; however, State law does not provide protection against habitat destruction in Georgia. Collection of this species on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. No such provisions are afforded to plants found on privately owned lands in the State. The species does not receive any specific legal protections from State laws or regulations in Alabama. (USFWS, 2016)

**Stressor:** Invasive Species (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** During the most recent range-wide survey, Schotz (2014) noted that invasive species are a potential threat to some Mohr's Barbara's buttons populations. Indeed, Schotz (2014) observed encroachment of exotic invasive plants species at 14 Mohr's Barbara's buttons sites. These species—predominantly Chinese privet (Ligustrum sinense)—left unchecked have the potential to degrade habitat quality and out-compete Mohr's Barbara's buttons for resources (e.g., moisture, nutrients, light, and recruitment sites). Currently, threats posed from invasive plants at most sites appears to be minimal (Schotz 2014); however, habitat management (e.g., fire, mechanical or hand thinning, etc.) may be required to control invasive species where they threaten Mohr's Barbara's buttons. (USFWS, 2016). Wild Hogs Rooting by wild hogs (Sus scrofa), which are non-native invasive species, was noted in the vicinity of some Mohr's Barbara's buttons occurrences in Bibb County, Alabama, but was not observed directly impacting Mohr's Barbara's buttons (M.S. Wiggers, pers. obs., August 2017). Although no direct impacts to Mohr's Barbara's buttons by wild hogs have yet been observed, wild hogs may represent an emerging threat to some populations. As has been summarized elsewhere, wild hogs can cause myriad deleterious effects—ranging from direct destruction of plants to degradation of habitat—on the communities in which they are found (cf. Massei and Genov 2004, Barrios-Garcia and Ballari 2012). Continued monitoring is needed to further assess the potential impacts and threats posed by wild hogs (USFWS, 2022).

**Stressor:** Small Population Size (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Most extant populations of Mohr’s Barbara’s buttons are comprised of a number of small, fragmented occurrences. While population sizes (i.e., number of plants obtained from counts or estimates) are not available for all sites/populations of Mohr’s Barbara’s buttons, the most recent range-wide status assessment by Schotz (2014) found that most sites had small local population sizes and that most of the range-wide population was contained in only a few sites with comparatively large local populations. Indeed, Schotz found that 53% (18 of 34) of extant sites had local populations of ≤100 individuals and 79% (27 of 34) of these sites had ≤200 individuals. Together, sites with ≤200 individuals accounted for about one-third of the total population evaluated by Schotz. By contrast, only three sites evaluated were found to have 500 or more plants, which accounted for nearly half of the entire population evaluated range-wide. Small population sizes increase the vulnerability of individual sites to environmental and anthropogenic perturbations and chance events. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species’ adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). (USFWS, 2016)

**Stressor:** Climate Change (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Specific impacts of climate change on populations of Mohr’s Barbara’s buttons are poorly understood; however, a variety of impacts are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Mohr’s Barbara’s buttons may be negatively impacted by climate change within Alabama as available habitat becomes constricted. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Mohr’s Barbara’s buttons. While disease is not currently known to threaten Mohr’s Barbara’s buttons, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004, Garrett et al. 2006, Hawkins et al. 2008). Given the variety and complexity of climate change’s potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Mohr’s Barbara’s buttons populations and habitats. (USFWS, 2016)

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 14

**Delisting Criteria:**
1. There are 15 viable populations and all are protected from present and foreseeable human-related and natural threats (USFWS, 1991)

2. At least three populations each should be located within the two physiographic regions represented by its historic range (Cumberland Plateau, Ridge and Valley) (USFWS, 1991).

3. At least three of the 15 populations should be located within Alabama and three in Georgia. Viability of populations will be assessed through monitoring for a period not less than 15 years (USFWS, 1991).

**Recovery Actions:**
- Protect existing populations from any present or foreseeable threats, and search for additional populations (USFWS, 1991)
- Determine population size. Conduct demographic studies and gather life history information (USFWS, 1991).
- Determine habitat characteristics. An understanding of this species ecology is an important component to determining what factors limit its distribution (USFWS, 1991).
- Determine parameters of a viable population. The long-term survival of the species will be ensured only if a sufficient number of viable populations are protected. (USFWS, 1991).
- Determine and implement appropriate management. Management of habitat, as well as protection, appears to be essential for ensuring that vigorous populations are maintained (USFWS, 1991).
- Conduct monitoring studies. A general monitoring program should be devised and implemented on sites in order to track population trends and evaluate the effectiveness of recovery efforts (USFWS, 1991).
- Preserve genetic material. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation (USFWS, 1991).
- Recommendations for Future Actions from 2016 5-Year Review: •Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. •Conduct studies to determine the number and distribution of populations required to maintain the species’ genetic diversity. •Investigate metapopulation structure and dynamics of the species. •Conduct studies into the species’ life history, biology, and ecology. •Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. •Update the species’ recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management). (USFWS, 2016)
- Personnel of the Alabama Highway Department (Department) are aware of the plants on or near the ROWs they maintain and of the importance of protecting them. An informal agreement exists between the U.S. Fish and Wildlife Service (Service) and the Department for protection of the plants on their ROWs (USFWS, 1991).
- One population on private land in Cherokee County is protected through a long-term Cooperative Agreement (USFWS, 1991).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The following actions are recommended to support and promote recovery of Mohr's Barbara's buttons. Use of a numbered list for these recommendations is for convenient reference and does not necessarily imply prioritization of any action over others. 1. Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. 2. Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. 3. Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. 4. Investigate metapopulation structure and dynamics of the species. 5. Conduct studies into the species' life history, biology, and ecology. 6. Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management) (USFWS, 2022).

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# SPECIES ACCOUNT: *Mentzelia leucophylla* (Ash Meadows blazingstar)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A biennial herb, up to 5 dm high. The leaves are densely covered with soft white hairs. Bright yellow flowers bloom from late May into September. Flowers open only for brief periods in late afternoon. (NatureServe, 2015)

**Taxonomy**

Possibly a variant of M. oreophila per Jim Morefield, NVHP. (NatureServe, 2015)

**Current Range**

Western slope and bajadas of mountain range in Ash Meadows, south Nye County, Nevada. (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 5/20/1985.

**Legal Description**

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Mentzelia leucophylla (Ash Meadows blazingstar) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

**Critical Habitat Designation**

The critical habitat designation for Mentzelia leucophylla includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation.  The PCEs of Mentzelia leucophylla critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include sandy or saline clay soils along canyon washes and near springs and seeps.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

<u>Adult:</u> Sexual (inferred from USFWS, 1990)

**Breeding Season**

Adult: Flowering continues from June to September (USFWS, 1990)

**Other Reproductive Information**

Adult: Flowering is exhibited by bright yellow flowers arranged in open, broad infloresences (USFWS, 1990)

**Reproduction Narrative**

Adult: The Ash Meadows Blazingstar is inferred to reproduce sexually. Its flowering season occurs from June to September. Flowers are bright yellow, arranged in open and broad infloresences (USFWS, 1990).

**Habitat Type**

Adult: Desert wetland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Springs and seeps that are fed by an extensive groundwater system; light-colored, fine-grained soils with a high salt content (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Local distribution of small populations (USFWS 1990)

**Environmental Specificity**

Adult: Very Narrow (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from USFWS 1990)

**Habitat Narrative**

Adult: This species inhabits desert wetland, near springs and along canyon washes maintained by springs and seeps that are fed by an extensive groundwater system. Found in light-colored, fine-grained soils with a high salt content, often growing with 2 other narrowly endemic plants: the Ash Meadows milk-vetch (Astragalus phoenix) and the Ash Meadows sunray (Enceliopsis nudicaulis var. corrugata) (NatureServe, 2015). The species is distributed locally in small populations. Tolerance ranges are inferred to be low (USFWS, 1990).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Little or no information exists on seed dispersal, seed germination, or seedling establishment in the wild. Additional dispersal/migration information is also lacking (inferred from USFWS, 1990).

***Population Information and Trends***

**Number of Populations:**

2 Max scale, 12 minimum scale (USFWS, 2020)

**Population Size:**

1,513 (USFWS, 2020)

**Population Narrative:**

There is little information about population level and species level trends. In 1997 there were 8 known populations, but the current population number estimate has been reduced to 1-5 populations (NatureServe, 2015).

***Threats and Stressors***

**Stressor:** Habitat disruption (USFWS 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Approximately 65 miles of gravel and unimproved roads now exist within the essential habitat, directly affecting this species (USFWS, 1990)

**Stressor:** Agricultural use (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Agricultural use presents a general threat to this species (NatureServe, 2015)

**Stressor:** Trampling by horses, cattle, and sheep (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Destruction by horses presents a general threat to this species (NatureServe, 2015)

**Stressor:** Proposed MX missile system (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The proposed MX missile system is considered to be a possible threat to this species (NatureServe, 2015)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8

**Delisting Criteria:**
1. All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar and Russian olive (USFWS, 1990).

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 1990).

3. Reestablish water to historic springbrook channels, which are free of barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic range (USFWS, 1990).

4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 1990).

5. Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 1990).

6. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats (USFWS, 1990).

7. All of the listed plant species and the candidate plant species are present in all the sites that they have historically occupied as identified in Appendix A Table XV of the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater that the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population (USFWS, 1990).

**Recovery Actions:**

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990)
- Conduct research on the biology of the species (USFWS, 1990)
- Conduct management activities within essential habitat (USFWS, 1990
- Reestablish populations/monitor new & existing populations (USFWS, 1990)
- Determine/verify recovery objectives (USFWS, 1990)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Over the next five years, the Service should focus on: • Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). • Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); • Support Ash Meadows blazingstar research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and • Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time.(USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Monitor compliance with the January 12, 2018, Nevada Revised Statute Order 1197A, Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, to ensure groundwater levels in Devils Hole can support the population (Nevada State Engineer 2018). Order 1197 is no longer in effect. Water levels in Devils Hole are affected by pumping centers in Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020); 2. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and the Ash Meadows Natural Resource Management Plan (Service 2020b); 3. Support Ash Meadows blazingstar research at the Refuge to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and 4. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM Area of Critical Environmental Concern surrounding the Refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the Refuge, but no active mining permits exist at this time. (USFWS, 2025)

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# SPECIES ACCOUNT: *Mimulus michiganensis* (Michigan monkey-flower)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

**Physical Description**

The Michigan monkey-flower is a member of the Scrophulariaceae (snapdragon) family and is an aquatic to semi-aquatic glabrous perennial herb with lax stems averaging 36 cm (14 in) in length. It roots at its lower stem nodes to produce clones of up to several hundred stems. The broadly ovate to roundish, opposite leaves are inconspicuously to coarsely sharp-toothed and evenly distributed along the stem. Bright yellow, snapdragon-like, tubular flowers, ranging from 16 to 27 mm (0.6 to 1.1 in) in length, are produced from the upper leaf axil and are borne on slender pedicels that may be longer than the leaves. The flowers have two upper lips and three-lobed lower lips, with the lower lip and tube irregularly spotted.

**Taxonomy**

Direct final rule (revised the scientific name from Mimulus glabratus var. michiganensis to Mimulus michiganensis) effective December 13, 2010. (USFWS, 2018).

**Current Range**

There are 19 element occurrences, including two historical occurrences (MNFI 2012) of MMF, ranging from Benzie and Leelanau counties to Mackinac County (Figure 3 and Appendix A). However, the majority of occurrences are clustered within the Mackinac Straits region. The newest colony was discovered in 2008 (MNFI 2012). Overall, the entire population is stable, although MMF colonies at a few sites are in decline (MNFI 2012). However, this information was obtained from records in which most have not been updated in more than 10 years (MNFI 2012). A systematic survey would provide a more accurate description of MMF abundance and population trends.

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: bloom from approximately mid-June to mid-August, extending occasionally into October.

**Reproduction Narrative**

Adult: Michigan monkey-flowers bloom from approximately mid-June to mid-August, extending occasionally into October. The fruit, which is seldom produced, consists of an oblong, pointed capsule around 8–10 mm (0.3–0.4 in) long, containing numerous oval seeds with longitudinal striations. Michigan monkey-flower essentially has no pollen viability and is nearly totally dependent on vegetative propagation via rhizomes (Bliss 1983, Bliss 1986). The Maple River population is the only population that has viable pollen and is capable of self-pollination (Posto and Prather 2000, Posto 2001). The taxon as a whole is also highly unlikely to produce seed asexually (Posto and Prather 2000). Because MMF depends primarily on vegetative propagation for reproduction, dispersal is greatly limited and likely occurs only locally through the fragmentation of clonal colonies.

**Habitat Type**

Adult: Alkaline spring seepages and streams

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Michigan monkey-flower is a very rare Michigan endemic that is restricted to cold, alkaline spring seepages and streams, usually in association with northern white cedar (Thuja occidentalis) swamps found along current or post-glacial Great Lakes shorelines. It frequently occurs in cedar swamps formed in drainages found at the base of relatively steep, moraine slopes and bluffs. Colonies of MMF have been found in muck-covered sand in cold, flowing water that ranged in temperature from 8.7° to 16.6°C (47.6° - 61.9°F), and with a pH of 7.66 to 8.21. However, research (Posto 2001) has shown that MMF seeds germinate best in light at approximately 23°C, suggesting that seed germination is probably highest along the water margins in the sun, rather than under water. Optimal habitat conditions for this plant are comprised of a combination of moderate to high light availability, cool substrate, and high nutrient availability within a narrow pH range, demonstrating its relatively specialized habitat requirements.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2018).

**Number of Populations:**

18 (USFWS, 2023)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

There are 19 element occurrences, including two historical occurrences (MNFI 2012) of MMF, ranging from Benzie and Leelanau counties to Mackinac County (Figure 3 and Appendix A). However, the majority of occurrences are clustered within the Mackinac Straits region. The newest colony was discovered in 2008 (MNFI 2012). Overall, the entire population is stable, although MMF colonies at a few sites are in decline (MNFI 2012). However, this information was obtained from records in which most have not been updated in more than 10 years (MNFI 2012). A systematic survey would provide a more accurate description of MMF abundance and population trends. Occurrences of Michigan monkey-flower are often localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small streams and spring-fed seeps within northern white cedar swamps (Penskar and Higman 2001). Large to moderately-sized populations include occurrences on Glen Lake, Burt Lake, and portions of the Mackinac County shoreline within the Manitou Payment Highbanks formation in the Brevort to Epoufette region (Penskar and Higman 2001). Relatively little population monitoring has been conducted for MMF, and thus the demography of its populations cannot be characterized. However, observations of colonies of the taxon through summer and winter seasons indicate that in fall colonies die back and become more or less dormant in streams and springs where water flow and temperature stay relatively constant, with colonies re-initiating growth in spring. Occurrences of Michigan monkey-flower are often localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small streams and spring-fed seeps within northern white cedar swamps (Penskar and Higman 2001). Large to moderately-sized populations include occurrences on Glen Lake, Burt Lake, and portions of the Mackinac County shoreline within the Manitou Payment Highbanks formation in the Brevort to Epoufette region (Penskar and Higman 2001). Range and distribution: Currently Michigan monkey-flower has 18 extant element occurrences. Recent surveys have indicated that at two areas, populations had extended beyond the area previously thought to be occupied and therefore, some adjacent element occurrences have been combined. The previous status review (2018) for Michigan monkey-flower listed 23 element occurrences. The species still occurs in the same six Michigan counties – Benzie, Leelanau, Charlevoix, Emmet, Cheboygan, and Mackinac (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Invasive Plants
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The greatest threat to MMF is direct destruction and modification of its habitat. Michigan monkey-flower’s habitat has been developed for recreational and residential purposes, which has led to severe impacts to and, in some cases, extirpation of historical populations. Hydrological disruptions also constitute a serious threat, as water diversion, warming of water sources, and other groundwater alterations lead to less than optimal habitat conditions. Consequently, this species may be inadvertently impacted by offsite activities. Populations of MMF are particularly vulnerable to extirpation due to low numbers and limited capability for sexual reproduction. Additionally, periodic high water levels of the Great Lakes and strong winter storms impact MMF habitat that occurs near the Great Lakes shoreline by redirecting seepage streams and opening the overstory by felling cedars. However, opening of the overstory may also benefit MMF by allowing for colonization. Invasive species, such as coltsfoot (Tussilago farfara) and reed canary grass (Phalaris arundinacea), represent an additional threat. Coltsfoot (Figure 2) is a very aggressive invasive plant growing within several MMF patches in the Glen Lake area (Jody Marquis, Mama Bear Restorations, Inc., pers. comm. 2010). It spreads rapidly via vegetative reproduction by rhizomes and windborne distribution of dandelion-like seed heads. The Glen Lake area provides habitat to several high-ranking MMF colonies and without intervention and control of coltsfoot, localized extirpations are likely. Reed canary grass, although not a current threat to MMF colonies, is present in the vicinity. Control of reed canary grass when it is not yet considered a threat, is most successful at this stage, and minimizes its chances of negatively impacting MMF in the Glen Lake area. (USFWS, 2016). Additional invasive plant threats posed by

marsh thistle (Cirsium palustre) and Canada thistle (Cirsium arvense). (USFWS, 2018).

**Stressor:** Climate change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. Climate change models predict the climate of the Great Lakes region will grow warmer and drier over the next century, with precipitation increasing in winter and decreasing in summer (AMEC 2006; Anton Reznicek, University of Michigan, pers. comm. 2004; Kling et al. 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10–20 percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling et al. 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling et al. 2003). Earlier models had indicated that increased precipitation, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000, AMEC 2006, Kling et al. 2003). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe et al. (2010) suggested that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lakes levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios. A warmer climate will also likely cause an increase in water temperatures that may facilitate the invasion of warm water-adapted species or exotic species (MacIsaac et al. 2002; AMEC 2006). Increased water temperatures will also result in decreased ice cover and, when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000, AMEC 2006). Additionally, AMEC (2006) predicts that increased precipitation will increase the flow rates of some rivers and streams, resulting in increased scouring, deposition of sediment, nutrients and pesticides, bank erosion, channel widening, and siltation of gravel beds and estuaries. Thus, climate change could significantly alter the natural stream morphology and likely make the habitat unsuitable for this Michigan endemic.

**Stressor:** Predation (USFWS, 2018).

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The NPS at Sleeping Bear Dunes National Lakeshore (Jennifer Chaffin, NPS pers. commun. 2011) observed evidence of deer browse in the past and, more recently, evidence of insect browse on Michigan monkey-flower plants in the vicinity of their Orr Restoration Site. The average insect browse in 2011 was three percent for the whole Michigan monkey-flower population within the restoration site while deer browse prior to 2011 was observed to be as much as 25 percent (Chaffin, pers. commun. 2011). (USFWS, 2018).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8C

**Recovery Actions:**

- The Michigan Monkey-flower Recovery Plan was approved on September 17, 1997 (USFWS 1997). The objective of the recovery plan is to secure long-term protection for all occurrences of MMF, thereby allowing reclassification, and ultimately, removal from the Federal List of Endangered and Threatened Wildlife and Plants. Michigan monkey-flower may be considered for reclassification from endangered to threatened status when protection is secured for all eight occurrences ranked “A - excellent” or “B - good” and delisted when all occurrences are sufficiently protected. The recovery goals listed in the recovery plan are: (1) long-term protection for all known existing occurrences, with primary emphasis on the preservation of essential habitat; (2) field surveys for new occurrences and to determine the specific status of recently discovered and historical sites; (3) biosystematics research to determine the most appropriate taxonomic classification, and; (4) demographic, physiological, breeding system, and genetic studies to understand population biology, specific habitat requirements, floral biology, and genetic variability, and long-term post-delisting viability monitoring.
- New in 2018 - 1: Develop a plan for conducting regular surveys, assessments, and monitoring at all known extant and historical Michigan monkey-flower locations. Continue exploration for new occurrences in the Lower Peninsula and eastern Upper Peninsula, and provide detail mapping of all occurrences. Document habitat and status conditions and population trends during these assessments. Recovery plan action numbers: 2-21, 2-22, 2-23, 2-45  Penskar (2012) was not able to access the Manitou Payment Highbanks occurrence due to a lack of permission from the landowner, and the historical Mullet Lake-West Shore occurrence was not accessed due to insufficient time and resources. Both of these sites should be considered priorities for future surveys. (USFWS, 2018).
- 2018 - 2: Research is needed to understand the genetic diversity within and between patches or populations. Recovery plan action number: 2-44 (USFWS, 2018).
- 2018 - 3: Research is needed to understand the genetic diversity within and between patches or populations. Recovery plan action number: 2-44 (USFWS, 2018).
- 2018 - 4: Work with public and private landowners, site managers, and other stakeholders to protect the species and its stream/seep habitat upstream, if possible. Acquire land containing occupied or suitable Michigan monkey-flower habitat. Recovery plan action numbers: 2-13, 2-15. (USFWS, 2018).

- 2018 - 5: Provide education and outreach to stakeholders and the public. Recovery plan action number: 1-121 (USFWS, 2018).
- 2018 - 6: Monitor approach of non-native species and control as appropriate. Recovery plan action number: N/A (USFWS, 2018).
- 2018 - 7: Evaluate if the fundamental recovery objective in terms of the number of previously known and newly discovered occurrences requiring long-term protection warrants revision. (USFWS, 2018).

***Conservation Measures and Best Management Practices:***

- Recommendations for future actions • Develop a plan for conducting regular surveys, assessments, and monitoring at all known extant and historical Michigan monkey-flower locations. It is especially important to prioritize populations that have not been surveyed in the last decade. An updated population status is crucial for these areas. Continue exploration for new occurrences in the Lower Peninsula and eastern Upper Peninsula and provide detail mapping of all occurrences. Document habitat and status conditions and population trends during these assessments. Recovery plan action numbers: 2-21, 2-22, 2-23, 4-45 • Monitor non-native and aggressive native species and control as appropriate. • Genetic research to understand the diversity among and between populations. Recovery plan action number: 2-44 • Acquire land containing occupied or suitable Michigan monkey-flower habitat. Create outreach materials for public and private landowners, site managers, and general stakeholders to inform and protect the species and its habitat. Recovery plan action numbers: 1-121, 1-122, 1-123, 1-15 (USFWS, 2023).

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# SPECIES ACCOUNT: *Mirabilis macfarlanei* (MacFarlane's four-o'clock)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/29/1979; Pacific Region (R1)

**Physical Description**

A herbaceous perennial with a deep-seated, thickened root. This species typically blooms from May through June. The bright pink flowers are conspicuous, up to 25 millimeters (1 inch) long by 25 millimeters (1 inch) wide. The flowers occur in inflorescences, which consist of a group of three to seven flowers subtended by a five-lobed involucre (saucer-shaped bract). The flowers are funnel-shaped with awidely expanding limb. Leaves are opposite, somewhat succulent, and broadly lanceolate to ovate. (USFWS, 2000)

**Taxonomy**

Mirabilis macfarlanei is a member of the four-o’clock family (Nyctaginaceae). It was first described in 1936 (Constance and Rollins 1936) from specimens collected along the Snake River Canyon. Mirabilis macfarlanei is morphologically similar to Mirabilis greenei, found in the Klamath region of California and Oregon. In contrast to M greenei, M macfarlanei has broader leaves and shorter, nearly round bracts (Constance and Rollins 1936). At least two other species of Mirabilis occur in the Pacific Northwest (M linearis and M bigelovii var. retrorsa), but these species do not overlap in distribution with M macfarlanei (Hitchcock and Cronquist 1973). (USFWS, 2000)

**Historical Range**

M. macfarlanei was known from only three populations along the Snake River Canyon in Oregon (Hell’s Canyon National Recreation Area) and the Salmon River Canyon in Idaho. (USFWS, 2000)

**Current Range**

Portions of the Snake, Salmon, and Imnaha river canyons in Wallowa County in northeastern Oregon, and adjacent Idaho County in Idaho. (USFWS, 2000)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (USFWS, 2016); Sexual (USFWS, 2000)

**Lifespan**

Adult: > 20 years (based on observations of individual plants) (USFWS, 2000)

**Breeding Season**

Adult: Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring.(USFWS, 2000)

**Other Reproductive Information**

Adult: Specific conditions required for germination and seedling survival are unknown (USFWS, 2000)

**Reproduction Narrative**

Adult: Mirabilis macfarlanei reproduces by seed, as demonstrated by the presence of seedlings with cotyledons and the documented survival of some of these seedlings in population monitoring studies (Kaye 1992). Vegetative reproduction by off-shoots beneath the soil surface also occurs. M. macfarlanei is primarily an outcrosser, but is able to produce a small proportion of one-seeded fruits through autogamy (self-pollination). Inflorescences bagged to exclude pollinators produced fewer fruits than open-pollinated inflorescences. Seed dispersal has not been studied, but apparently seeds fall to the ground and are transported by gravity and rain (Kaye 1992). Seed viability is low.; Mirabilis macfarlanei is a taprooted perennial that reproduces by seed, but also colonizes via long spreading rhizomes. Individual plants tend to produce a few to several hundred stems in clusters ranging up to about nine square meters in size (Callihan 1988). The species has been able to persist in areas historically grazed by livestock since the 1870's, and presently in poor ecological condition. Preliminary data suggests grazing may have a negative effect on plant height, but additional research is needed (Kaye 1995). The most serious consequences of livestock grazing are likely indirect, most notably habitat degradation. At one site in Idaho, the number of M. macfarlanei plants appears to be stable several years after a range fire. An increase in Bromus tectorum, however, suggests that habitat degradation is an ongoing problem. The underground stems of M. macfarlanei would survive most natural fires, especially since they would likely occur later in the summer, when the plant is dormant. Genetic studies (Barnes 1994; 1995; Wolf et al. 1994) have shown that measures of genetic diversity in M. macfarlanei were lower than for plants with a similar life history. The greatest level of gene flow occurred between populations that were 0.5 km apart. Levels of gene flow decreased as distances between populations increased.; ASEXUAL; Perfect; Predominantly outcrossing (NatureServe, 2015).

**Habitat Type**

Adult: River canyon slopes (USFWS, 2016)

**Environmental Specificity**

Adult: Narrow (USFWS, 2016)

**Habitat Narrative**

Adult: Gentle to very steep, open river canyon slopes. Aspects vary, but are usually southeast to west. Soils are often sandy and underlain by talus. Mirabilis macfarlanei occurs in river canyon habitats characterized by regionally warm and dry conditions. Precipitation occurs mostly as rain during the winter and spring. Sites are dry and open, or with scattered shrubs. Plants can be found on all aspects, but most often on southeast to western exposures. Slopes are often steep, but range to nearly flat. Plants can occur along any slope position. Soils vary from sandy to rocky. Talus rock often underlies the soil substrate and several sites are relatively unstable and prone to erosion. The associated vegetation is usually in early to mid-seral condition, and the grasslands are typically grazing modified versions of Agropyron spicatum communities. In a habitat analysis study conducted at a site in Oregon, the vegetation associated with a population of M. macfarlanei appeared to be influenced by aspect, soil development and topographic position, at least on a local scale (Kaye 1992). Nearby sites without M. macfarlanei had a higher number of weedy annual species, and more gentle slopes with deeper, more stable soils (USFWS, 2016).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds apparently fall near the parent plant and are transported by gravity and rain water. It is possible that M macfarlanei seeds may be dispersed by birds or mammals, but seed dispersal has not been studied for this species. No information exists on whether M macfarlanei maintains a soil seed bank (USFWS, 2000)

***Population Information and Trends***

**Population Trends:**

Stable (USFWS, 2016)

**Number of Populations:**

13 (USFWS, 2022)

**Population Narrative:**

Mirabilis macfarlanei occurs within the geographic area identified in the 2000 Recovery Plan: the Salmon, Snake, and Imnaha river canyons in Idaho and Oregon. The species occurs in 13 Element Occurrences (EOs), 9 in Idaho and 4 in Oregon. Land ownership is comprised of BLM, Forest Service, and private lands. Of the 13 EOs, 5 are located on BLM land, 1 is located on both BLM and private land, 4 are located on Forest Service land, 1 is located on both Forest Service and private land, and 2 are located solely on private land. Both the BLM and the Forest Service continue to conduct surveys for Mirabilis macfarlanei. The Forest Service conducted surveys in the Hells Canyon National Recreation Area, Wallowa-Whitman National Forest annually from 2007 through 2014. Approximately 4,700 acres of suitable habitat were surveyed over the 8 year period, with an average of nearly 600 acres per year. The BLM surveyed an average of approximately 1,000 acres of suitable habitat on BLM lands annually from 2010 through 2015. Despite these survey efforts, no new M. macfarlanei populations have been discovered since the last 5-year review in 2009. The BLM has established a new population of Mirabilis macfarlanei at the Lower Otto Creek Conservation area located on BLM land. The BLM worked cooperatively with a local private landowner to transplant approximately 25 rhizomes from private property to the Lower Otto Creek Conservation area in April 2015 (in accord with the FWS Section 7 Biological Opinion (dated July 22, 2011) prepared for the Shroyer Trail and Lower Otto Creek Conservation Area project). This population has not yet been counted as a new EO. Future monitoring will document the success of this transplanting. Monitoring data show an overall stable population trend for Mirabilis macfarlanei. In 2000, one of the action items identified in the M. macfarlanei Recovery Plan was to monitor population trends (U.S. Fish and Wildlife Service 2000). In 2007, the Service funded a project to synthesize and analyze monitoring data collected by the BLM between 1981 and 2004, and the Wallowa-Whitman NF from 2001 to 2006, and to provide a general review of the respective monitoring programs (Mancuso and Shepherd 2008). Among its results, analysis found no significant change in M. macfarlanei ramet abundance over the years at most monitored occurrences. Mirabilis macfarlanei forms colonies from an extensive lateral root system that can extend up to 10 meters (33 feet; Yates 2007).

Clonal shoots emanating from the same root system are referred to as ramets. Collectively, these genetically identical ramets comprise a genet (or the individual plant). While this review acknowledged the impressive monitoring datasets, which included over 20 years of data collection, it also included a set of recommendations to improve the efficiency and value of the BLM and Forest Service monitoring efforts. One of these recommendations was the development and implementation of a rangewide monitoring strategy (U.S. Fish and Wildlife Service 2007; U.S. Fish and Wildlife Service 2009). In response, a collaborative effort to develop and implement a new, standardized, rangewide monitoring program for M. macfarlanei was initiated in 2010. Development of the new monitoring program was guided by management objectives identified by the Service, the BLM, and the Forest Service. The overall purpose of the new monitoring plan is to provide more comprehensive documentation and a better understanding of the rangewide conservation status of M. macfarlanei. The monitoring program is designed to collect quantitative information on M. macfarlanei and its habitat. A full description of the monitoring protocol is provided in Mancuso 2011. Ten Mirabilis macfarlanei transects were sampled in 2010 to test the proposed new monitoring protocols. Transect locations represented eight suboccurrences within six M. macfarlanei EOs. Monitoring results comparing 2010 results to pre-2010 datasets indicated that overall, M. macfarlanei percent frequency values for 2010 were similar to pre-2010 mean values and analysis found no significant difference ($p<0.05$) in 2010 frequency compared to pre-2010 mean values for any of the monitoring plots sampled in 2010 (Mancuso 2011, p. 13). These data support the 2008 findings by Mancuso and Shepard (2008) that suggest the Mirabilis macfarlanei "population size" is stable rangewide (Mancuso 2011, p. 13). Monitoring data has not been reanalyzed since 2005 because the new monitoring protocol has not yet been established at all Mirabilis macfarlanei EOs. In addition, monitoring sites that have been established are monitored on a rotation. Annual monitoring is not conducted due to concerns regarding excessive researcher disturbance that can result from trampling of the fragile soils on steep slopes where these plants occur (USFWS, 2016). The species occurs in 13 officially recognized Element Occurrences (EOs), 9 in Idaho and 4 in Oregon, with just a few thousand individual plants occurring among them [Idaho Fish and Wildlife Information System (IFWIS) database; the Oregon Biodiversity Information Center (ORBIC) database; and additional reports from Idaho (Hill et al. 2020)]. An EO is the distinct geographic location where a species occurs. Plants are typically tracked as EO records by State or province Natural Heritage Programs or Conservation Data Centers and are determined by grouping together occurrences into a single population (or "Element Occurrence") if they occur within 1.6 kilometers (1 mile) of one another. While Idaho uses the 1.6 km separation distance it should be noted that Oregon uses a 500-meter separation distance. The 13 officially recognized EOs includes one established population, Lucile Caves (EO ID 7), which was established by the BLM in 1988. In addition to the 13 officially recognized EOs, an additional EO, Lower Otto, was established in 2015 by the BLM, bringing the total number of MacFarlane's four-o'clock populations to 14. Because this population was recently established, it has not been included in the IFWIS database and therefore does not have an EO number yet. These established populations will be discussed in more detail below under Population Augmentation and Establishment. See Table 1 for a list of all EOs and associated land ownership (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Grazing by livestock and wildlife
**Exposure:**

**Response:**
**Consequence:** Loss of habitat
**Narrative:** Although it is uncertain whether most or all M macfarlanei populations have been grazed by domestic livestock in the past, livestock grazing still occurs at some sites. Livestock impact this species directly by trampling or consuming plants, and can result in reduced reproduction (i.e., seed set) for M macfarlanei plants. Native and introduced ungulate species, including Rocky Mountain bighorn sheep (Ovis canadensis), Rocky Mountain elk (Cervus elaphus), and mountain goats (Oreamnos americanus), are found in the vicinity of M macfarlanei habitat in Hell's Canyon National Recreation Area and the Salmon River Canyon. Although evidence of herbivory by rabbits and deer has been observed, native wildlife species do not appear to significantly threaten this species. However, the potential introduction of additional Rocky Mountain bighorn sheep or mountain goats by State or Federal agencies could threaten M macfarlanei habitat. Mountain goats and other ungulate species can impact rare plant habitat by trampling or consuming plants and by exposing mineral soil. (USFWS, 2000)

**Stressor:** Invasive nonnative plant species
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Exotic (non-native) plant species pose a serious threat to M macfarlanei and other native plants since they compete with native species for space, light, water, and nutrients. Two of the most serious exotic species are Brornus tectorum (cheatgrass) and Centaurea soistitiatis (yellow star-thistle). Centaurea sotstitialis infestations have increased significantly in the Snake River Canyon over the past decade. Efforts to control Centaurea sotstitialis have been initiated at a few sites containing M macfarlanei(USFWS, 2000). This threat was listed as a primary threat in the 2015 5-year review (USFWS, 2015).

**Stressor:** Wildfire or Fire History
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Specific effects of historic and current fire regimes on M macfarlanei are unknown. Fire suppression activities and rehabilitation efforts, including seeding with normative species, are a potential threat to this species. It is possible that M macfarlanei habitat has bumed less frequently in the past 100 years due to fire suppression. Sites where fire has been excluded are vulnerable to accelerated succession, e.g., the invasion of shrubs or trees into grassland or meadow communities. However, the invasion of cheatgrass alters natural community dynamics by producing greater fine fuel levels, which may result in frequent, large-scale range fires. In areas where cheatgrass has invaded sagebrush-grass communities, altered fire dynamics have converted formerly productive, perennial communities to annual-dominated communities with increased fire management problems. Wildfires that occur during summer and fall months when M macfarlanei plants are dormant may have minimal direct effects on this species since the underground rhizomes will be largely insulated from fire. However, fires may result in adverse changes in the ecological condition of sites and lead to the subsequent invasion of exotic species. Burning may also result in concentrations of ungulates grazing within the burned areas, which might cause increased trampling of M macfarlanei plants. The primary concern from wildfires appears to be during the active growing period (typically April through June) when the aboveground plants would be susceptible to fire kill or injury (USFWS, 2000). This threat was

stated to be a primary threat in the 2015 5-year review (USFWS, 2015).

**Stressor:** Herbicide and pesticide spraying
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Spraying vegetation in areas where M macfarlanei occurs could potentially have an adverse effect on this species if weed control activities are not carefully implemented and monitored. (USFWS, 2000)

**Stressor:** Landslides and flood damage
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Activities associated with flood damage repair, including maintaining roads, trails, and facilities damaged by landslides or flooding, should be considered as a potential threat to M macfarlanei habitat. (USFWS, 2000)

**Stressor:** Insect damage and disease
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some M. macfarlanei plants have been damaged by insects, including lepidopterans and spittle bugs. A type of fungal disease was also previously noted from M macfarlanei plants. Because of connections between ramets, diseases may spread rapidly through clonal plant populations. Although damage from insects and disease do not currently appear to be significant in M macfarlanei populations, these threats should be monitored. (USFWS, 2000)

**Stressor:** Trampl‌ling, off-road vehicle use, road maintenance/construction
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-road vehicles:  Several M macfarlanei colonies are found within 0.5 kilometer (1/4 mile) of existing roads or highways in Idaho and Oregon. In addition, many M macfarlanei colonies are on steep slopes that are particularly vulnerable to erosion. Uncontrolled off-road vehicle use is a potential threat to this species on both public and private lands. -- Road and trail construction and maintenance:  Some M macfarlanei populations in Idaho and Oregon are located near existing roads and trails, and could be adversely impacted by road or trail maintenance activities. The construction of new roads or trails is also a threat to this species. (USFWS, 2000)

**Stressor:** Collection
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mirabitis macfarlanei is an attractive plant that could be sought by amateur or professional botanists for scientific or horticultural purposes. Because some colonies are readily accessible, collection of M macfarlanei should be considered a potential threat to this species.

(USFWS, 2000)

**Stressor:** Mining
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although no populations are currently known to be impacted by mining, one M macfarlanei population is located near an existing gravel mining operation along the Salmon River in Idaho County, Idaho. In addition, road construction is often associated with mining activity. The Hell's Canyon National Recreation Area is closed to any new mining claims. However, expansion of existing mining operations and development of future mining operations(e.g., borrow pits) should be considered a potential threat to M macfarlanei. (USFWS, 2000)

**Stressor:** Competition for pollinators
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Preliminary observations have shown that successful pollination of M macfarlanei may be hindered by competition from adjacent plant species. For example, researchers have noted the presence of mixed pollen loads on solitary bees, which are considered to be potential pollinators of M macfarlanei. No data currently exists on the natural history (e.g., biotic and abiotic requirements) of the primary pollinators of M macfarlanei. It is unknown whether pollinator populations are adequate for the successful reproduction of M macfarlanei at all sites, although one study found that seed set in M macfarlanei does not appear to be pollen limited. (USFWS, 2000)

**Stressor:** Inbreeding depression.
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Some observers have noted that seedling recruitment isapparently rare in populations of M macfarlanei. This could be influenced by extrinsic factors such as competition, inadequate pollination, nutrient levels, or annual precipitation. Inbreeding depression could result in poorseed viability, reduced germination success, orpoor seedling survivorship. If new individuals are not successfully added to the population, the population viability of M macfarlanei may decrease over time. (USFWS, 2000)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 11

**Delisting Criteria:**
A minimum of 11 populations are secure from threats and naturally reproducing with stable or increasing population trends for at least 15 consecutive years. (USFWS, 2015)

Population sizes are above the minimum necessary to maintain the viability of the species. (USFWS, 2015)

Populations of this species occur throughout its current range in each of three geographic areas (i.e., Imnaha, Snake, and Salmon River areas). (USFWS, 2015)

Management practices reduce and control threats. On Federal land, habitat management plans are in place and monitoring is used to ensure implementation and effectiveness of conservation management practices. On non-Federal lands, M. macfarlanei populations are managed and conserved. (USFWS, 2015)

A post-delisting monitoring program for the species is developed and implemented. This program will be developed through coordination with the BLM, Forest Service, FWS, and other interested parties. (USFWS, 2015)

**Recovery Actions:**

- Task 1: Protect essential habitat and control threats: Protect essential (occupied and potentially suitable) habitat and implement actions that may be necessary to eliminate or control threats. Manage habitat to maintain or enhance viable populations of M macfarlanei. Habitat should be managed to allow for the maintenance of natural ecosystem functions and processes and contribute to the long-term preservation of this species. Because M macfarlanei populations are genetically distinct), all populations should be protected in order to maintain the genetic variability of this species. (USFWS, 2000)
- Task 2: Monitor population trends and habitat conditions: Achieving recovery will require monitoring of both M. macfarlanei individuals and habitat throughout its range in Idaho and Oregon. Monitoring will provide information on threats to M macfarlanei habitat, and will also provide feedback on the effectiveness of management and conservation activities. (USFWS, 2000)
- Task 3: Conduct research essential to the conservation of the species: Additional research on the reproductive biology and life history of M. macfarlanei needs to be conducted to ascertain whether these recovery objectives are valid. Information on life history, population characteristics, and habitat requirements should be obtained to allow specification of management and population goals. Partnerships with other State, Federal, or private agencies and individuals should be developed where possible in order to meet these objectives. The Fish and Wildlife Service will work with appropriate agencies to ensure that adequate funding can be obtained to conduct essential research on M. macfarlanei . (USFWS, 2000)
- Task 4: Conduct surveys in potential habitat areas. Manage and protect any newly discovered M. macfarlanei populations.: Intensive field work should be conducted to locate additional populations of this species in each of the three geographic areas in which it is currently known (i.e., along the Imnaha, Salmon, and Snake River corridors in Idaho and Oregon). The habitat of any newly discovered populations should be protected and managed as necessary and appropriate following the protocol given in Task 1.
- Task 5: Establish propagule banks, including a long-term seed storage facility for M. macfarlanei. Seeds of M. macfarlanei should be collected according to currently accepted protocol, and stored at a long-term seed storage facility such as the Berry Botanic Garden (Portland, Oregon). Seeds from many M. rnacfarlanei sites are currently being stored at the Berry Botanic Garden. Additional seeds will be collected to capture as much of the species'

genetic variability as possible. Berry Botanic Garden staff will also be conducting germination and propagation studies for M. macfarlanei. The Fish and Wildlife Service will assist with securing permits for activities as appropriate. (USFWS, 2000)

- Task 6. If warranted. establish and maintain new populations. If M. macfarlanei is extirpated from formerly occupied areas, or if population viability analyses suggest that additional populations are needed for full recovery, new populations of M. macfarlanei may be established as necessary and appropriate. (USFWS, 2000)
- Task 7. Validate and revise recovery objectives, as needed. The recovery plan should be modified to incorporate any new information as it becomes available. In particular, the results of any population viability analyses conducted for M macfarlanei will be considered in future recovery plan revisions. The recovery plan should be reviewed every 5 years. and updated if necessary. (USFWS, 2000)
- Continue working as an interagency technical team to collaborate on recovery actions for this species. (USFWS, 2015)
- Continue control efforts of invasive nonnative plant species and noxious weeds. The Service suggests developing site-specific management plans and monitoring schedules for individual EOs. (USFWS, 2015)
- Develop and implement studies to assess general life history and ecological needs, including studies addressing soil chemistry and moisture regimes. (USFWS, 2015)
- Continue to pursue opportunities to work with landowners towards conservation of this species on private lands. (USFWS, 2015)
- Continue the rangewide monitoring program and conduct and a 10-year analysis of the data set. (USFWS, 2015)
- Continue survey efforts to locate potential new populations. (USFWS, 2015)

***Conservation Measures and Best Management Practices:***

- Recommendations for Future Actions: • Conduct an SSA for Macfarlane's four-o-clock, with an emphasis on incorporating more current climate change modeling. • Using the information gathered in the SSA determine if a revised Recovery Plan is warranted. • Continue working as an interagency technical team to collaborate on recovery actions for this species. • Complete site-specific HMPs. • Continue the plant propagation program (through both nursery and micropropagation), identification of appropriate areas for population establishment, and associated outplanting efforts at new and existing populations. • Continue control of invasive nonnative plant species and noxious weeds, and conduct research to inform effectiveness of these treatments. • Continue to work with partners to mitigate impacts from livestock grazing. • Develop and implement studies to determine if sexual reproduction is occurring. • Utilize the recommendations in the 2020 rangewide monitoring report to revise the monitoring protocol and continue the rangewide monitoring program. • Continue survey efforts to locate new populations using the newly developed Habitat Suitability Model (USFWS, 2022).

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# SPECIES ACCOUNT: *Monardella viminea* (Willowy monardella)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A perennial herb or subshrub in the Lamiaceae (mint family) with a woody base and aromatic foliage. (USFWS, 2012)

**Taxonomy**

Monardella viminea was previously recognized and listed as Monardella linoides ssp. viminea. In 2003, Elvin and Sanders proposed a taxonomic split of this entity into two distinct species. Upon recognition of this taxonomic change and species split, the range of the listed entity was reduced, and the southernmost occurrences were reclassified as Monardella stoneana. For more details regarding the taxonomic classification of Monardella linoides ssp. viminea as a distinct species (M. viminea) and reclassifying a portion of Monardella linoides ssp. viminea as a separate species (M. stoneana), and the consequences of recognizing this split, please refer to the revised final listing and revised critical habitat rule published in the Federal Register on March 6, 2012 (USFWS 2012b, pp. 13394–13447) (USFWS, 2022).

**Current Range**

Occurs in coastal sage scrub and riparian scrub in sandy bottoms and on banks of ephemeral washes in canyons where surface water flows for usually less than 48 hours after a rain event (Scheid 1985, p. 3; Elvin and Sanders 2003, p. 430; Kelly and Burrascano 2006, p. 51). Monardella viminea is a geographically narrow endemic species restricted to three watersheds north of Kearny Mesa in San Diego County, California 2012 5-year Review for Monardella viminea 3 (Elvin and Sanders 2003, p. 431). Within these watersheds, M. viminea occurs on land owned by the Department of Defense at Marine Corps Air Station (MCAS) Miramar, the City of San Diego, the County of San Diego, and private parties. (USFWS, 2012)

**Critical Habitat Designated**

Yes; 3/6/2012.

**Legal Description**

On March 6, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Monardella viminea (Willowy monardella) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (77 FR 13394-13447).

**Critical Habitat Designation**

The critical habitat designation for Monardella viminea includes two CHUs in San Diego County, California. This species critical habitat encompasses approximately 122 acres (ac) (50 hectares (ha)) (77 FR 13394-13447).

Unit 1: Sycamore Canyon: Unit 1 consists of 118 ac (48 ha), and is located in Sycamore Canyon at the northeastern boundary of MCAS Miramar, north of Santee Lakes in San Diego County, California. These acres fall within the boundaries of the City of Santee, which has no approved

MSCP. This canyon is the only place where Monardella viminea is found in oak woodland habitat, and is one of the few areas in the range of M. viminea with mature riparian habitat (Rebman and Dossey 2006, p. 23). Sycamore Canyon is essential to the recovery of the species because it supports over 350 individual plants, or approximately 18 percent of the species' total population (City of San Diego 2010a, p. 257; Tierra Data 2011, p. 12), meaning this is an important unit that supports genotypes and diversity not found among the more impoverished occurrences. Additionally, this canyon is one of few that contains seedlings and juveniles (Tierra Data 2011, pp. 16–17), demonstrating that reproduction is occurring and the habitat in this unit is currently suitable to support all lifehistory phases of this declining species. The habitat in this unit provides redundancy and resiliency for M. viminea and, since there are areas of suitable habitat within the canyon where plants are not currently growing, the unit provides space for the growth and expansion of the species. This unit contains the physical or biological features essential to the conservation of M. viminea, including riparian channels with a natural hydrological regime, ephemeral drainages made up of rocky or sandy alluvium, sandy soil with sediment and cobble deposits, and surrounding vegetation that provides semi-open foliar cover. The PCE may require special management considerations or protection to address threats from nonnative plant species and erosion of the canyon (City of San Diego 2005, p. 68; 2006, p. 10; 2009, p. 2). Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to M. viminea habitat and potential management considerations.

Unit 2: West Sycamore Canyon: Unit 2 consists of 4 ac (2 ha) of land owned by water districts, and is located in West Sycamore Canyon adjacent to the eastern section of MCAS Miramar, in San Diego County, California. The northernmost point of the unit is just outside the boundary of MCAS Miramar. West Sycamore Canyon, in which Unit 2 is found, is essential to the recovery of Monardella viminea because it contains the largest number of M. viminea individuals of any canyon in the species' range and over 25 percent of the species' total population (Tierra Data 2011, p. 12), meaning this is an important unit that supports genotypes and diversity not found among the more impoverished occurrences. Additionally, this canyon is one of few that contains seedlings and juveniles (Tierra Data 2011, pp. 16–17), demonstrating that reproduction is occurring and the habitat in this unit is currently suitable to support all lifehistory phases of this declining species. The plants in this canyon were recently observed to be in good health with little to no pressure from herbivores, in contrast to many other areas such as San Clemente or Carroll Canyon, where individuals are declining or are in poor health (Tierra Data 2011, p. 25; Ince 2010, Table 3). The habitat in this unit provides redundancy and resiliency for M. viminea, and because there are areas of suitable habitat within the canyon where plants are not currently growing, the unit provides space for the growth and expansion of the species. Unit 2, which contains critical habitat for M. viminea in that portion of West Sycamore Canyon located outside of MCAS Miramar, includes the physical or biological features essential to the conservation of M. viminea, including riparian channels with a natural hydrological regime, ephemeral drainages made up of rocky or sandy alluvium, sandy soil with sediment and cobble deposits, and surrounding vegetation that provides semi-open foliar cover. The PCE in this unit may require special management considerations or protection to address threats associated with erosion from heavy rainfall events. Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to M. viminea habitat and potential management considerations.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Monardella viminea critical habitat consists of four components (77 FR 13394-13447):

(i) With a natural hydrological regime, in which: (A) Water flows only after peak seasonal rainstorms; (B) High runoff events periodically scour riparian vegetation and redistribute alluvial material to create new stream channels, benches, and sandbars; and (C) Water flows for usually less than 48 hours after a rain event, without long-term standing water;

(ii) With surrounding vegetation that provides semi-open, foliar cover with: (A) Little or no herbaceous understory; (B) Little to no canopy cover; (C) Open ground cover, less than half of which is herbaceous vegetation cover; (D) Some shrub cover; and (E) An association of other plants, including Eriogonum fasciculatum (California buckwheat) and Baccharis sarothroides (broom baccharis);

(iii) That contain ephemeral drainages that: (B) Are made up of coarse, rocky, or sandy alluvium; and (C) Contain terraced floodplains, terraced secondary benches, stabilized sandbars, channel banks, or sandy washes; and

(iv) That have soil with high sand content, typically characterized by sediment and cobble deposits, and further characterized by a high content of coarse, sandy grains and low content of silt and clay.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the physical or biological features within the geographical area occupied by the species at the time of listing that are essential to the conservation of the species may require special management considerations or protection. The areas designated as critical habitat will require some level of management or protection to address the current and future threats to the physical or biological features. In all units, special management considerations or protection may be required to provide for the sustained function of the ephemeral washes on which Monardella viminea depends. The features essential to the conservation of Monardella viminea may require special management considerations or protection to reduce the following threats, among others: Cover by nonnative plant species that crowds, shades, or competes for resources; habitat alteration due to altered hydrology from urbanization and associated infrastructure; and any actions that alter the natural channel structure or course, particularly increased water flow that could erode soils inhabited by M. viminea or cover them with sediment deposits. Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include, but are not limited to: Removal of nonnative vegetation by weeding, planting of native species along stream courses in canyons to help control erosion, use of silt fences to control erosion, restriction of development that alters natural hydrological characteristics of stream courses in canyons, and implementation of prescribed burns. Additionally, specialized dams and smaller barriers could be installed in canyons to help address floodwater runoff that results from upstream development (which can cause erosion and loss of clumps of Monardella viminea), although these dams must be of adequate size and strength to withstand increased storm flow caused by urbanization.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Vegetative (USFWS, 2008); Sexual (USFWS, 2012)

**Dependency on Other Individuals or Species**

Adult: Bees and butterflies (USFWS, 2012)

**Reproduction Narrative**

Adult: The willowy monardella is a perennial species that reproduces at least in part vegetatively (USFWS, 2008). It also reproduces sexually. Monardella viminea is visited by numerous bees and butterflies, and is likely pollinated by a diverse array of insects. Specific species which pollinate M. viminea have not been identified (USFWS, 2012).

**Habitat Type**

Adult: Sandy washes and floodplains (USFWS, 2008)

**Dependencies on Specific Environmental Elements**

Adult: Perennial streams; ecosystem culture, function, and integrity; coarse, rocky, and sandy alluvium on terraced floodplains; semi-open canopies of coastal sage and riparian scrub with limited herbaceous understory (USFWS, 2008)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2008)

**Habitat Narrative**

Adult: The willowy monardella inhabits sandy washes and floodplains. The species is dependent on several environmental elements: perennial streams; ecosystem culture, function, and integrity; coarse, rocky, and sandy alluvium on terraced floodplains; semi-open canopies of coastal sage and riparian scrub with limited herbaceous understory (USFWS, 2008)

***Dispersal/Migration***

**Dispersal**

Adult: Low (inferred from USFWS, 2008)

**Dispersal/Migration Narrative**

Adult: The species is inferred to have low dispersal ability based on a limited historic range and its proximity and vulnerability to urban development (inferred from USFWS, 2008)

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2008)

**Number of Populations:**

16 Extant EO's (USFWS, 2022)

**Population Size:**

Up to 6,000 total individuals, as many as six populations of fewer than 15 individuals (USFWS, 2008)

**Population Narrative:**

The willowy monardella is in decline at the population level. There are 8 extant occurrences (USFWS 2012) and at least 10 documented extirpated occurrences. The overall population is 6,000 individuals, but as many as six populations have fewer than 15 individuals. Species resiliency, representation, and redundancy are inferred to be low based on its vulnerability to stochastic events (USFWS, 2008). In summary, monitoring for Monardella viminea has occurred at 20 occurrences since 2012 (Table 1), providing new information about the species presence and abundance. We reassessed our previous occurrence status determinations and updated the status of four occurrences. Additionally, information was added for 3 EOs omitted from the previous 5-year review, 1 was merged with another EO, and 10 are new occurrences reported since 2012. Based on those updates, there are now 30 occurrences of M. viminea (Figure 1; Table 1) of which 16 are extant, 2 are presumed extant, 2 are possibly extirpated, and 10 are extirpated (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Grazing/trampling; urban and residential development; recreational activities; altered hyrological regimes; road construction; soil removal; sand and gravel mining; trash dumping; erosion; wildfires; invasive plants (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species is threatened by several anthropogenic activities including grazing/trampling,urban and residential development, recreational activities, altered hydrological regimes, road construction, soil removal, sand and gravel mining, trash dumping, and erosion. Wildfires have also had an adverse effect on the species. Invasive plants such as bulrush and willow can take over otherwise suitable habitat for willowy monardella, a process likely exacerbated by fires (USFWS, 2008). Trampling of M. viminea occurs via human travel through the species' habitat. Nonnative plants threaten the species as they frequently out-compete native species for limited resources and grow more quickly, can smother seedling and mature M. viminea and prevent natural growth (Rebman and Dossey 2006, p. 12). Nonnative plants also have the potential to lower water tables and alter rates of sedimentation and erosion by altering soil chemistry, nutrient levels, and the physical structure of soil (USFWS, 2012).

**Stressor:** Urbanization and development (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Urbanization and development were recognized as threats to Monardella viminea in the listing rule and the 2012 revised final listing and critical habitat rule (USFWS 1998, p. 54946; 2012b, pp. 13398–13399). While most occurrences of M. viminea are found on land conserved or owned by MCAS Miramar, and the City or County of San Diego, development continues to be a threat at four occurrence (EOs 8, 12, 14, and 24) and was a contributing factor to extirpation at

seven occurrences historically (EOs 3, 4, 5, 6, 11, 25, and 39). Since the last 5-year review, EOs 5, 6, and 39, which were not discussed in the previous 5-year, are considered extirpated due to development (Table 1). Additionally, M. viminea occurrences remain indirectly threatened from surrounding urbanization due to higher levels of impervious surface areas that increase dry season runoff (AECOM 2022, p. 3). This increased runoff converts ephemeral drainages to a permanently wet state, promoting conversion to riparian habitat (USFWS, 2022)

**Stressor:** Altered Hydrology (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Altered hydrology was discussed as a significant threat to habitats that support Monardella viminea at listing and in the 2012 revised final listing and critical habitat rule (USFWS 1998, p. 54950; 2012b, p. 13399). Natural hydrological systems are required by M. Viminea to maintain and deposit material for secondary benches and streambeds on which the species grows (Sheid 1985, pp. 30–31, 34–35). Furthermore, a natural hydrological regime helps reduce competition from woody riparian species and nonnative grasses through scouring and erosion events; however, excessive scouring and erosion can reduce growth or damage M. viminea (Vernadero 2021, p. 53). Hydrological changes may occur within watersheds due to upstream urban development and precipitation changes that affect daily median and minimum discharges, dry season runoff, and flood magnitudes (White and Greer 2006, pp. 133–136). In the 2012 analysis, EOs 3, 4, and 11 were listed as extirpated due to altered hydrological patterns. Altered hydrology has continued to threaten Monardella viminea habitat throughout its range. Since the last review, altered hydrology has been identified as a threat during monitoring conducted by SDMMP on MSPA lands at EOs 1 (MOLIV_6LOCA004), 8 (MOLIV_4SYCA006), 21 (MOLIV_4WSCA003), and 29 (MOLIV_4SYCA001; MOLIV_4SYCA002) (CBI and AECOM 2021a, pp. 345–346). Loss or damage of M. viminea clumps was documented on MCAS Miramar following large scouring events during the 2015–2016 and 2016–2017 growing seasons (Vernadero 2021, pp. 53, 57). Additionally, some plants located in San Clemente Canyon (EO 35) were washed away after heavy rains in the past several years (Gordon 2022, pers. comm.). In summary, 10 occurrences are potentially impacted by the threat of altered hydrology (CDFW 2021) (USFWS, 2022).

**Stressor:** Nonnative Plant Species (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nonnative plants were identified as a threat to Monardella viminea in the listing rule and in subsequent 5-year reviews (USFWS 1998, p. 54950; 2008, pp. 11–12; 2012b, p. 13404). This threat is ongoing, and nonnatives are listed as a threat at 11 out of 30 occurrences (CDFW 2021, pp. 1, 4–5, 9, 11–12, 15, 18, 22, 25, 37). Nonnative plants are present throughout all canyons on MCAS Miramar where M. viminea occurs. During the 2020 surveys, Vernadero (2021, pp. 32–34) observed nonnative plant cover in all but two monitoring plots. In some plots, nonnatives were the dominant plant species cover (Vernadero 2021, p. 32). In review comparing plot photographs captured in 2012 to photos captured in 2017 and 2020, surveyors noted the most distinguishable pattern was the increase in nonnative species (Vernadero 2021, p. 52). In monitoring completed off the MCAS Miramar base, SDMMP noted nonnatives as a medium (threat occurs in 10 to 50 percent of area within maximum extent) or high (threat occurs in 50 to

100 percent of area within maximum extent) level threat in 5 out 7 occurrences monitored in 2019 (CBI and AECOM 2021a, pp. 343–346) (USFWS, 2022).

**Stressor:** Climate Change (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The term “climate change” refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2013, p. 1450). Downscaled projections under several future climate scenarios are available for the range of Monardella viminea (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
None listed

Recovery Priority Number: 8

**Recovery Actions:**

- The Cities of San Diego and Santee have purchased private property as reserve land for Monardella viminea (USFWS, 2012)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to Monardella viminea and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Continue to monitor known M. viminea occurrences to update occurrence status, size, and threats. That information can be used to identify high-priority occurrences for management or areas for restoration. Work with landowners to implement management strategies as identified in the MSP Framework Rare Plant Management Plan (see CBI and AECOM 2021a, pp. 354–369). 2. Determine habitat characteristics that support M. viminea growth, survival, and reproduction. Identify areas of potential supportive habitat for reintroduction. 3. Enhance habitat where M. viminea occur, through nonnative plant control, flood control, and anti-erosion measures where necessary. Test available herbicides to learn their effect on M. viminea and determine whether it could be used to control nonnative grasses and forbs without negatively affecting M. viminea. 4. Identify suitable introduction/reintroduction sites to expand current distribution of M. viminea in areas where suitable habitat is present. Conduct habitat restoration to support pollinators, if necessary. 5. Research effects of drought and high temperatures on M. viminea recruitment and survivorship (USFWS, 2022).

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# SPECIES ACCOUNT: *Monolopia (=Lembertia) congdonii* (San Joaquin wooly-threads)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/19/2000; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

The common name "woolly-threads" is derived from the many long (up to 45 cm; 18 in), trailing stems covered with tangled hairs. However, San Joaquin woolly-threads plants also can be tiny (< 7 cm (3 in)) and erect with a single stem (Cypher 1994a). The tiny, yellow flower heads are clustered at the tips of the stems and branches. Each flower head is approximately 6 mm (0.25 in) long and contains two types of florets (the tiny flowers characteristic of the aster family); the four to seven outer florets differ in shape from the numerous inner florets. The two types of florets produce achenes (tiny, one-seeded fruits) that also differ in shape (Johnson 1993, Taylor 1989). (USFWS, 1998)

**Taxonomy**

n 1883. Gray named San Joaquin woolly-threads as Eatonella congdonii. The type specimen had been collected by Congdon near Deer Creek (Tulare County) in that same year. The current name, Leinbertia congdonii, was published by Greene in 1897, who determined that San Joaquin woolly-threads should be separated from snowy eatonella (Eatonella nivea). Subsequent taxonomists have upheld Greene's taxonomy (Johnson 1993, Taylor 1989). San Joaquin woolly-threads is the sole species in the genus Lembertia, which is in the aster family (Asteraceae). (USFWS, 1998)

**Historical Range**

The historical range of San Joaquin woolly-threads is based on 47 herbarium specimens and literature reports dating from 1883 to 1983; 30 of the occurrences were from the floor of the San Joaquin Valley, four were from the CuyamaValley. and the remainder were in the hills west of the San Joaquin Valley. These occurrences were concentrated in eight areas (in descending order of abundance): (1) the plains between Avenal and Mendota in Kings and Fresno Counties, (2) from Bakersfield to Shafter in Kern County, (3) the inner Coast Ranges of western Fresno and eastern San Benito Counties, (4) from north of Lokern to Lost Hills in Kern County, (5) the Carrizo and Elkhorn Plains in San Luis Obispo County, (6) the Cuyama Valley in Santa Barbara County, (7) east of Edison in Kern County, and (8) the type locality. However, 33 of the historical occurrences had been eliminated by 1989 (Taylor 1989). (USFWS, 1998)

**Current Range**

The Service states that Monolopia congdonii occur in Fresno, Kings, Kern, San Benito, San Luis Obispo, and Santa Barbara Counties. Nineteen populations of Monolopia congdonii were extant (55 FR 29361). Twelve populations remained in the San Joaquin Valley and adjoining foothills from the vicinity of Panoche Pass (San Benito County) southeasterly to Caliente Creek east of Bakersfield (Kern County). Another seven populations occurred to the southwest in the Cuyama Valley (San Luis Obispo and Santa Barbara Counties) and Carrizo Plain (San Luis Obispo County). Thirty-three of 52 historical populations had been lost (55 FR 29361), including a population from Tulare County (Taylor 1989). (USFWS, 2010)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: February to April (USFWS, 2010)

**Reproduction Narrative**

Adult: San Joaquin woolly-threads is an annual herb, and its phenology varies with weather and site conditions. Monolopia congdonii typically flowers between late February and early April (B. Delgado pers. comm. from Service 1998). Each plant may have from 1 to more than 400 flower heads. Seed production depends on plant size and the number of flower heads but can range from 10 to 2,500 seeds per individual (Mazer and Hendrickson 1993; Cypher 1994; E. Cypher unpublished data from Service 1998). (USFWS, 2010)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Chenopod scrub, valley and foothill grassland; sand dunes (Skinner, 1997). (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Prefers less than 10% shrub cover; found at elevations between 200 to 850 feet on the San Joaquin Valley and from 2,000 to 2,600 feet in San Luis Obispo and Santa Barbara counties (USFWS, 2010)

**Spatial Arrangements of the Population**

Adult: Scattered (USFWS, 2010)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: Monolopia congdonii occurs scattered in Nonnative Grassland, Valley Saltbush Scrub, Interior Coast Range Saltbush Scrub, and Upper Sonoran Subshrub Scrub communities (Service 1998). Plants that often occur with Monolopia congdonii include Bromus rubens (red brome), Erodium cicutarium (red-stemmed filaree), Schismus spp. (Arabian grass), Lasthenia spp. (goldfields), and Vulpia myuros (mouse tail fescue). Monolopia congdonii typically occupies microhabitats with less than 10 percent shrub cover, although herbaceous cover may be either sparse or dense, and cryptogamic crust (a layer of moss, lichen, and algae on the soil surface) may or may not be present. Monolopia congdonii occurs on neutral to sub-alkaline soils that were deposited in geologic times by flowing water. On the San Joaquin Valley floor, this species typically is found on sandy or sandy loam soils, particularly those of the Kimberlina series, whereas on the Carrizo Plain, it occurs on silt rich soils. Monolopia congdonii frequently occurs on sand dunes and sandy ridges as well as along the high-water line of washes and on adjacent terraces. Occurrences have been reported at elevations ranging from approximately 200 to 850 feet on the San Joaquin Valley floor and surrounding hills, and from 2,000 to 2,600 feet in San Luis Obispo and Santa Barbara Counties (Service 1998). (USFWS, 2010)

***Dispersal/Migration***

**Dependency on Other Individuals or Species for Dispersal**

Adult: Possibly wind, water and animals (USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: Seed dispersal agents are unknown, but possible candidates include wind, water, and animals. Insect pollinators are not known to be required for seed-set in M. congdonii (Mazer and Hendrickson 1993); however, animals may be important to this plant species in other ways. (USFWS, 2010)

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2020)

**Number of Populations:**

87 (USFWS, 2020)

**Population Narrative:**

Currently, there are 87 extant and presumed extant Diversity Database occurrences, and 24 extirpated and possibly extirpated occurrences. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Agricultural conversion and urbanization (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The loss and modification of habitat due to agricultural conversion and urban development remain the largest threats to Monolopia congdonii. As discussed in the final listing rule (55 FR 29361), 96 percent of the native habitats of the valley floor had been lost primarily to urbanization and agricultural land conversion by 1987. The Central Valley Project (CVP) is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the State's 58 counties. Agricultural conversions and related operations either directly or indirectly facilitated by the Central Valley Project include: conversion of native habitats to agricultural fields; conversion of land use to more water intensive purposes; disposal of agricultural drainwater; application of pesticides; and other mowing and harvesting operations. Agricultural conversion and related operations have contributed to the loss and degradation of several habitat types, including grasslands and alkali scrub associated with declines of multiple listed species (Service 1998). Currently, fewer than 150,000 acres on the San Joaquin Valley floor remain uncultivated; most of the remaining undeveloped land is located near, or in, the

foothills at the valley perimeter.  Significant portions of these lands not cultivated for agriculture or urbanized have been developed for petroleum extraction, strip-mined for gypsum and clay, or occupied by roads, canals, airstrips, oil-storage facilities, pipelines, and evaporation and percolation basins.  In addition, natural communities have been permanently altered by the introduction and proliferation of nonnative plants, which now dominate many remaining natural habitats (USFWS 1998).  Residual natural communities are typically comprised of marginal and highly fragmented habitats.  Habitat conditions are so marginal in many of these residual communities that the elimination of listed species is likely, if catastrophic events such as drought or floods were to occur (Service 1998).    The California Department of Conservation (CDC) estimates that the conversion of farming or grazing land to residential or industrial uses between 2002 and 2004 in the San Joaquin Valley occurred at a rate of 26 acres per day (CDC 2007).  The projected rate of development is anticipated to increase (American Farmland Trust 2007).  As urbanization encroaches into valley floor agricultural areas, Monolopia congdonii habitats of the foothills are increasingly converted to perennial cropland. Other effects due to agriculture include soil salinization resulting from irrigation; a pattern that has been observed throughout history (Jacobsen and Adams 1958) where agriculture land use dominates arid regions.  Soil salinization due to agriculture is common in California's San Joaquin Valley (Schoups et al. 2005; T. Maurer, Service, pers. comm. 2010) and may result in impairment to soil that would make restoration of habitat unlikely. In Fresno County, where Monolopia congdonii occurs, human population growth and urbanization have steadily increased.  For the period between 1990 and 2000, population growth in Fresno County increased 16.5 percent (California Department of Finance 2007). (USFWS, 2010)

**Stressor:** Oil and gas extraction and conveyance (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oil and gas extraction and conveyance continue to threaten Monolopia congdonii. Adverse effects of oil and gas development on M. congdonii include the loss of habitat, change in habitat quality, destruction of individuals or populations and their seedbank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. On the BLM lands where Monolopia congdonii occurs, oil and gas exploration is also a threat to the species' survival and recovery. (USFWS, 2010)

**Stressor:** Habitat threats from solar power developments (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Solar power development projects pose potential threats to and may impact large amounts of habitat.  These projects can destroy, fragment, or impact Monolopia congdonii habitat by:  altering landscape topography, vegetation, and drainage patterns; and reducing habitat quality through interception of solar energy normally reaching the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (Smith 1984; Smith et al. 1987 as cited in J.R. Single, CDFG. in litt. 2010).  Moreover, recently proposed solar projects tend to be large contiguous blocks of disturbance in undeveloped habitat lands, ranging from hundreds to several thousand acres. (USFWS, 2010)

**Stressor:** Off road vehicle use

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off road vehicle use for recreational purposes is among the threats to Monolopia congdonii recorded in the CNNDB since 1990. The Kettleman Hills BLM population is reportedly under increasing threat from off road vehicle trespass (O'Dell in litt. 2007). Off road vehicle recreational use on Federal lands is often difficult to control due to limited staffing and area remoteness such as in the Kettleman Hills (O'Dell in litt. 2007). As of 2010, off road vehicle use continues to be a threat at Kettleman North Dome where BLM land is "checker-boarded" with Chevron oil fields. Chevron is making efforts to exclude off road vehicles by improving their fences and patrolling the area. There is also some existing threat of off road vehicle activity impact to the species and its habitat on Monocline Ridge, although this threat is lower than at the much more accessible Kettleman North Dome (O'Dell in litt. 2010). Off road vehicle use has been reported as a minor threat on the Carrizo Plain National Monument (BLM 2009). The threat of off road vehicle recreation use on private lands where Monolopia congdonii persists is unknown. (USFWS, 2010)

**Stressor:** Conservation measures (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The California Wildlife Conservation Board purchased 3,000 acres from TNC in December 1988 and 2,500 acres in 1989 to be managed by CDFG. Currently, the Carrizo Plain National Monument (formerly the Carrizo Plain Natural Area) contains over 200,000 acres of natural habitat. The Monument is jointly managed by the BLM, CDFG and The Nature Conservancy (TNC) (California Resources Agency 2008). Although, as discussed above, 130,000 acres within the Monument are open to potential oil and gas development. (USFWS, 2010)

**Stressor:** Grazing (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In the final rule (55 FR 29361) we listed overgrazing (by domestic livestock) as a threat. Currently, we think that either the complete removal of grazing, uncontrolled grazing, or grazing that continues during the flowering time of Monolopia congdonii are threats to M. congdonii. Cattle grazing exclusion in one of BLM's populations in Jacalitos Canyon appears to have resulted in extirpation of that population, coincident with heavy accumulation of annual grass biomass (O'Dell in litt. 2010). The Bakersfield BLM office has noted the same effect of livestock exclusion resulting in plant number declines on part of population at Kettleman Middle Dome (O'Dell in litt. 2010). In contrast, cattle grazing on one of BLM's populations at Kettleman North Dome has maintained grass biomass low to the ground, which has greatly benefitted Monolopia, resulting in a population numbering in the thousands that is continuing to increase in size (O'Dell in litt. 2010). Grazing may be detrimental if it continues into the flowering period of M. congdonii (Cypher 1996). (USFWS, 2010)

**Stressor:** Herbivory (USFWS, 2010)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Herbivory by giant kangaroo rats has been shown to reduce the reproductive capacity of individual Monolopia congdonii plants by up to 30 percent. The intensity of the damage to individual plants is correlated with distance from a burrow (Mazer and Hendrickson 1993). Monolopia congdonii growing on kangaroo rat precincts has been noted and attributed to the suggestion that the species is a poor competitor with introduced annual grasses (Taylor 1989). On the Carrizo Plain, greater M. congdonii plant size and flower head production has been associated with giant kangaroo rat activity (Mazer and Hendrickson 1993) as have been earlier seed germination and maturation (Cypher 1994). (USFWS, 2010)

**Stressor:** Competition from non-native grasses (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The southern San Joaquin Valley of California, as with much of western North America, has been invaded by nonnative plant species during the past 100 to 200 years. These include the following species: Bromus rubens (red brome), Vulpia myuros (mouse tail fescue), Schismus arabicus (Arabian grass), Hordeum murinum ssp. glaucum (known locally as foxtail and elsewhere as smooth barley), Bromus diandrus (ripgut brome), and Bromus hordeaceus (soft chess) (Biswell 1956; Heady 1977; Germano et al. 2001). These introduced grasses often germinate with the first October rains (J. Jones, Live Oak Associates, pers. comm. 2007) and become established before Monolopia congdonii seeds germinate. This allows nonnative plants to out-compete native plant species for water, nutrients, and sun light and places M. congdonii at a reproductive disadvantage. An overabundance of residual thatch from the previous year's nonnative grass production can have similar adverse effects by shading out or obstructing M. congdonii seedlings. Competition from nonnative grasses affects Monolopia congdonii on both private and public lands including the Carrizo Plain National Monument. (USFWS, 2010)

**Stressor:** Nitrogen deposition/landscape nitrification (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Elevated atmospheric nitrogen (N) deposition is particularly harmful to N-limited ecosystems such as Monolopia congdonii habitat in the arid southern San Joaquin Valley where it leads to increases in nonnative annual grasses which outcompete the native flora (Fenn et al. 2003). Dry nitrogen deposition estimates for Bakersfield, Kern County near a CNDDB Monolopia congdonii occurrence, are 10 to 20 kilograms of N per hectare per year (22 to 44 pounds of N per 2.5 acres per year) (Blanchard et al. 1996). Nitrogen limited ecosystems of the western United States, such as the arid/semi-arid San Joaquin Valley, are adversely affected by N deposition as low as 3 to 8 kilograms of N per hectare per year (7 to 18 pounds of N per 2.5 acres per year) (Fenn et al. 2003). (USFWS, 2010)

**Stressor:** Trampling by livestock and soil compaction (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Trampling by livestock reduces survival of Monolopia congdonii in areas where livestock congregate, such as around water troughs. Trampling from livestock is a threat when it

reduces or eliminates the reproductive ability of the plant by, for example, damaging blossoms or seeds. Soil compaction resulting from domestic livestock may be less of an effect in habitat areas where soils have a low clay fraction than in soils with a high clay fraction. In some areas, such as the valley floor, M. congdonii is typically found on sandy or sandy loam soils (Service 1998). The Kimberlina soil series, which the plant is known to occupy, consists of very deep, well drained soils on flood plains and recent alluvial fans (Natural Resources Conservation Service 2003). In other types of soil, compaction is likely a threat to individual Monolopia congdonii. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The change in global climate presents a threat to Monolopia congdonii. Climate models predict for California an overall warming of 1.7 degrees to 5.8 degrees Celsius (3.0 degrees Fahrenheit to 10.4 degrees Fahrenheit) by 2100 (Cayan et al. 2006) but vary in their predictions for precipitation. VanRheenen et al. (2004), however, predicts a decrease in precipitation in the southern San Joaquin Valley. Any significant changes in temperature or precipitation could have drastic effects on M. congdonii populations. Climate change will likely result in changes in the vegetative communities of M. congdonii habitat and potentially increase nonnative species. However, there is insufficient data available at this time to predict the specific effects of climate change on M. congdonii. (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
1. 95 percent of occupied habitat on public land is secured and protected from incompatible uses. (USFWS, 2010)

2. A management plan is approved and implemented for recovery areas that include survival of the species as an objective. (USFWS, 2010)

3. Population monitoring in specified recovery areas shows stable or increasing numbers in all protected areas through one precipitation cycle. (USFWS, 2010)

**Delisting Criteria:**
1. 640 acres (260 hectares) or more of occupied habitat in the Lost Hills (Kern County) and one or more other sites on the San Joaquin Valley floor of 640 acres or more has been secured and protected from incompatible uses. (USFWS, 2010)

2) Population monitoring in specified recovery areas shows no decline after downlisting, if declining, determine cause and reverse trend. (USFWS, 2010)

3) Though not explicitly stated, the delisting criteria include meeting all of the downlisting criteria (Service 1998). (USFWS, 2010)

**Recovery Actions:**

- Develop and implement a regional cooperative program and participation plan. (USFWS, 1998)
- Protect and secure existing populations. (USFWS, 1998)
- Determine distributions and population statuses of featured species. (USFWS, 1998)
- Conduct important research and monitoring. (USFWS, 1998)
- Maintain and establish linkages in existing natural lands and between islands of habitat on the Valley floor and natural lands around the fringe of the Valley. (USFWS, 1998)
- Apply adaptive management to protected areas (Priority 3). (USFWS, 1998)
- If necessary, reintroduce selected featured species to appropriate habitat within their historic range. (USFWS, 1998)
- Periodically review the status of candidates and species of concern to determine if listing as endangered or threatened is necessary. (USFWS, 1998)
- Protect existing habitat in the San Joaquin Valley for Monolopia congdonii. (USFWS, 2010)
- Conduct surveys to determine trends in the range-wide status of the species and population abundance. (USFWS, 2010)
- Collect seeds from multiple populations adhering to the Center for Plant Conservation Guidelines (1991). Store seeds in facilities certified by the Center for Plant Conservation. (USFWS, 2010)
- When BLM revises the ACEC management plan, address invasive species, wildlife habitat improvements, and the protection/enhancement of special status species throughout the Panoche-Coalinga ACEC. Ensure that habitat can be protected in blocks of at least 160 acres and buffer zones of 500 feet or more are protected beyond the occurrence margins of Monolopia congdonii to reduce external influences and to allow for plant population expansion. (USFWS, 2010)
- Conduct research to determine the degree or intensity of threat from livestock grazing to the plant and its habitat. Include the variables of cattle stocking rate, relative weight or size of animals, numbers, and cattle sheltering or shade selection behavior. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2010 5-year review (Service 2010), scientific literature, and as a result of discussions with species experts. 1. Protect existing habitat in the San Joaquin Valley for San Joaquin woolly-threads. 2. A comprehensive evaluation should be completed for all known occurrences (both extant and extirpated). The site-specific evaluation should include, at minimum, whether the species is present, the estimated population/occurrence size, and an in-depth analysis of threats at that location. 3. Implement and/or continue yearly surveys utilizing a standardized methodology to determine trends in the range-wide status of the species as well as population/occurrence abundance. 4. Continue studies that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful re-establishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. 5. Conduct research to determine the degree or intensity of threat from livestock grazing to the plant and its habitat. Include the variables of cattle stocking rate, relative weight or size of animals, numbers, and cattle sheltering or shade selection behavior. 6. Analyze the potential for habitat degradation due to climate change and implement appropriate measures to ameliorate these threats. (USFWS, 2020)
- Habitat Conservation Plans are planning documents required as part of an application for an incidental take permit. They describe the anticipated effects of the proposed taking; how those

impacts will be minimized, or mitigated; and how the Habitat Conservation Plan is to be funded. Habitat Conservation Plans can apply to both listed and non-listed species, including those that are candidates or have been proposed for listing. Regional Habitat Conservation Plans develop large-scale conservation strategies within a specific region that are designed to conserve functional ecological systems and the covered species that depend on them. Such Habitat Conservation Plans aim to avoid a fragmented conservation landscape by working with local land use authorities and a designated implementing entity to conserve, enhance, and manage a preserve system. Project-level Habitat Conservation Plans are designed to fully offset the impacts associated with the permitted activity by contributing to a larger conservation design. Being included as a covered species under a Habitat Conservation Plan can result in habitat being set aside and managed for the species as mitigation for impacts associated with covered activities, such as planned urban development, within the Habitat Conservation Plan permit area. In addition to mitigation, avoidance, minimization, and other conservation measures (e.g. monitoring, seasonal work windows, habitat management, etc.) are implemented. Habitat Conservation Plans can also utilize banks, in-lieu fee programs, or other mechanisms to preserve habitat in perpetuity and contribute to a regional conservation strategy. The following are Habitat Conservation Plans that include this species and the year the permit for the Habitat Conservation Plan was issued: PG&E San Joaquin Valley Operations & Maintenance Habitat Conservation Plan 2007, Nuevo-Torch 1999, Kern Water Bank 1997, and Chevron Pipeline 1996. More information about Habitat Conservation Plans that include San Joaquin woolly-threads as a covered species can be found at: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=3746 (USFWS, 2020)

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# SPECIES ACCOUNT: *Navarretia fossalis* (Spreading navarretia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

Navarretia fossalis (spreading navarretia), a member of the Polemoniaceae (phlox family), is a low, mostly spreading or ascending annual plant, 4 to 6 in (10 to 15 cm) tall. The leaves are 0.4 to 2 in (1 to 5 cm) long and finely divided into slender spine-tipped lobes. The lower portions of stems are mostly hairless (glabrous). The flowers are arranged in flat-topped, compact, leafy heads. The white to lavender-white petals (corolla) are joined at their bases to form a tube, although the tips (lobes) are free. The fruit is an ovoid, two-chambered capsule. Each seed is covered by a layer that becomes sticky and viscous when the capsule is moistened. (USFWS, 2010)

**Taxonomy**

The range of N. fossalis overlaps with two other species in the genus Navarretia: N. intertexta (needle-leaved navarretia) and N. prostrata (prostrate navarretia). Navarretia fossalis is distinguished from the other two species by its linear corolla lobes, spreading or ascending habit, flat topped inflorescences, calyx size and shape (sepals collectively), and the position of the corolla relative to the calyx (Day 1993, p. 846). (USFWS, 2010)

**Historical Range**

See current range/distribution.

**Current Range**

The range of Navarretia fossalis extends from northwestern Los Angeles County to western Riverside County, and coastal San Diego County in California, to northwestern Baja California, Mexico (Figure 1). At the time of listing, 34 populations were considered extant in the United States, including populations contained in the listing rule and in the Recovery Plan. Nearly 60 percent of these populations were concentrated at three locations: Otay Mesa in southern San Diego County, alongside the San Jacinto River in western Riverside County, and near Hemet in western Riverside County (Bramlet 1993, pp. 10, 14; Bauder 1986a, pp. 4-11, 4-14). At listing, N. fossalis occupied less than 300 acres (120 hectares) of habitat in the United States (Service 1998b, p. 54978) (USFWS, 2023).

**Critical Habitat Designated**

Yes; 10/7/2010.

**Legal Description**

On October 7, 2010, the U.S. Fish and Wildlife Service (Service), designated final revised critical habitat for Navarretia fossalis (spreading navarretia) under the Endangered Species Act of 1973, as amended (75 FR 62192 - 62255). In total, approximately 6,720 acres (ac) (2,720 hectares (ha)) of habitat in Los Angeles, Riverside, and San Diego Counties, California, fall within the boundaries of the critical habitat designation. This final rule constitutes an overall increase of approximately 6,068 ac (2,456 ha) from the 2005 critical habitat designation for N. fossalis.

**Critical Habitat Designation**

The revised critical habitat designation for Navarretia fossalis includes six units totaling 6,720 acres in in Los Angeles, Riverside, and San Diego Counties, California. The units are Unit 1: Los Angeles Basin-Orange Management Area, Unit 2: San Diego: Northern Coastal Mesa Management Area, Unit 3: San Diego: Central Coastal Mesa Management Area, Unit 4: San Diego: Inland Management Area, Unit 5: San Diego: Southern Coastal Mesa Management Area, and Unit 6: Riverside Management Area.

Unit 1: Los Angeles Basin—Orange Management Area. Unit 1 is located in northwestern Los Angeles County and consists of two subunits totaling 176 ac (71 ha) of private land. Subunit 1A: Cruzan Mesa. Subunit 1A is located near the City of Santa Clarita in Los Angeles County. This subunit is on Cruzan Mesa, northwest of Forest Park and the Sierra Highway and southwest of Vasquez Canyon Road. Subunit 1A consists of 156 ac (63 ha) of private land and meets the selection criteria as satellite habitat. Cruzan Mesa is one of the only areas in Los Angeles County that supports mesatop vernal pools. As satellite habitat, this subunit supports a stable occurrence of Navarretia fossalis, provides potential connectivity with Subunit 1B, and likely supports a genetically distinct occurrence because of the separation of these two northern occurrences from other occurrences of N. fossalis. This subunit and Subunit 1B (described below) represent the most northern occurrences of this species. Subunit 1A contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as mowing or grading) that occur in the vernal pool basins. Subunit 1B: Plum Canyon. Subunit 1B is located near the City of Santa Clarita in Los Angeles County. This subunit is in Plum Canyon, west of Forest Park and the Sierra Highway and north of Plum Canyon Road. Subunit 1B consists of 20 ac (8 ha) of private land and meets the selection criteria as satellite habitat. As satellite habitat, this subunit supports a stable occurrence of Navarretia fossalis, provides potential connectivity with Subunit 1A, and likely supports a genetically distinct occurrence because of the separation of these two northern occurrences from other occurrences of N. fossalis. The Plum Canyon vernal pool habitat occurs on a flat area down-slope from the vernal pools on Cruzan Mesa. The vernal pools on Cruzan Mesa (Subunit 1A) and Plum Canyon represent the only habitat for N. fossalis in Los Angeles County and the most northern occurrences of this species. Subunit 1B contains the physical or biological features essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species within this subunit.

Unit 2: San Diego—Northern Coastal Mesa Management Area. Poinsettia Lane Commuter Station. Unit 2 is located in the City of Carlsbad in San Diego County and contains 6 ac (3 ha) of land owned by the North County Transit District and 3 ac (1 ha) of private land. This unit is loosely bounded by Avenida Encinas on the north, a housing development on the east, Poinsettia Lane on the south, and train tracks on the west. Unit 2 meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences on MCB Camp Pendleton and Subunits 4C1, 4C2, and 4D. The Poinsettia Lane vernal pool complex consists of a series of vernal pools that run parallel to a berm created by the train tracks. Unit 2 contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins.

Unit 3: San Diego—Central Coastal Mesa Management Area. Unit 3 is located in central coastal San Diego County and consists of three subunits totaling 103 ac (42 ha). This unit contains 102 ac (42 ha) owned by State and local governments, and approximately 1 ac (less than 1 ha) of private land. Subunit 3B: Carroll Canyon. Subunit 3B is located in the City of San Diego in San Diego County. This subunit is located to the southwest of the intersection of Parkdale Avenue and Osgood Way, and is loosely bounded by residential development on the north, open space to the east, and a quarry to the south and west. Subunit 3B consists of approximately 18 ac (7 ha) that includes 17 ac (7 ha) of land owned by State or local governments and 1 ac (less than 1 ha) of private land. Subunit 3B meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 3A and 3C. The Carroll Canyon vernal pool complex consists of a group of vernal pools on the edge of a mesa north of Carroll Canyon. Historically, there may have been more habitat for this species; however, the majority of vernal pool habitat in the vicinity of this subunit has been developed. Subunit 3B contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as trespass or illegal trash dumping) that occur in the vernal pool basins. Subunit 3C: Nobel Drive. Subunit 3C is located in the City of San Diego in San Diego County. This subunit is loosely bounded by the 805 interstate on the northeast, train tracks on the south, and Nobel Drive on the northwest. Subunit 3C consists of 37 ac (15 ha) of land owned by local government and meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 3B and 3D. The Nobel Drive vernal pool complex consists of a group of vernal pools on a mesa-top north of Rose Canyon. Subunit 3C contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 3D: Montgomery Field. Subunit 3D is located in the City of San Diego in San Diego County. This subunit is located at Montgomery Field (airport) to the northeast of the runway area. Subunit 3D consists of 48 ac (20 ha) of land owned by the City of San Diego and meets the selection criteria as satellite habitat. As satellite habitat, this subunit supports a stable occurrence of Navarretia fossalis and provides potential connectivity with the occurrence in Subunit 3C. The Montgomery Field vernal pool complex consists of a large group of vernal pools east of the runway area at Montgomery Field, although only the northeastern portion of this vernal pool complex is being designated as critical habitat because the southeastern portion of this vernal pool complex has been hydrologically disconnected from other vernal pools by past development, is now isolated, and does not meet the definition of essential habitat. Navarretia fossalis has not been documented in the southeastern portion of this vernal pool complex. Subunit 3D contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species that occur in the vernal pool basins.

Unit 4: San Diego—Inland Management Area. Unit 4 is located within inland San Diego County and consists of four subunits totaling 206 ac (83 ha). This unit contains 18 ac (7 ha) owned by State and local governments, and 188 ac (76 ha) of private land. Subunits 4C1, 4C2, and 4D: San Marcos. Subunits 4C1, 4C2, and 4D are located in the City of San Marcos in San Diego County. These three subunits consist of three separate vernal pool complexes. The first (Subunit 4C1) is loosely bounded by La Mirada Drive on the northeast, Las Posas Road on the southeast, Linda Vista Drive on the southwest, and South Pacific Street on the northwest. The second (Subunit 4C2) is loosely bounded by Linda Vista Drive on the northeast, Las Posas Road on the east, West San Marcos Boulevard on the south, and South Pacific Street on the west. The third (Subunit 4D) is loosely bounded by South Bent Avenue on the northeast, commercial development on the southeast and southwest, and Linda Vista Drive on the northwest. Subunit 4C1 consists of 34 ac (14 ha) of private land, Subunit 4C2 consists of 15 ac (6 ha) of land owned by local government and 17 ac (7 ha) of private land, and Subunit 4D consists of 5 ac (2 ha) of private land. These three subunits meet the selection criteria as satellite habitat areas because they support stable occurrences of Navarretia fossalis and provide potential connectivity between occurrences in Unit 2 and Subunit 4E. The Service grouped these vernal pool complexes because of the clustered nature of these occurrences. These subunits have separate subunit numbers to be consistent with the numbering identified in the 2005 critical habitat designation. Subunits 4C1, 4C2, and 4D contain the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats from nonnative plant species and activities (such as commercial development, trespass, or OHV use) that occur in the vernal pool basins. Subunit 4E: Ramona. Subunit 4E is located in the unincorporated community of Ramona. This subunit is loosely bounded by the Ramona Airport and Ramona Airport Road on the north, Sawday Road on the east, Santa Maria Creek on the south, and a series of rock outcrops on the west. Subunit 4E consists of approximately 135 ac (55 ha) that includes 3 ac (1 ha) of land owned by State or local governments and 132 ac (53 ha) of private land. Subunit 4E meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity with occurrences in Subunits 4C1, 4C2, and 4D. The vernal pools in this subunit occur in gently sloping grassland habitat and are at the highest elevation where N. fossalis is known to occur. Subunit 4E contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as agricultural activities or recreational use) that occur in the vernal pool basins.

Unit 5: San Diego—Southern Coastal Mesa Management Area. Unit 5 is located in southern San Diego County and consists of six subunits totaling 748 ac (303 ha). This unit contains 28 ac (11 ha) of federally owned land, 330 ac (134 ha) of land owned by State and local governments, and 390 ac (158 ha) of private land. Subunit 5A: Sweetwater Vernal Pools. Subunit 5A is located southwest of the Sweetwater Reservoir. This subunit is loosely bounded by the Sweetwater Reservoir on the north, steeply sloping topography on the east, State Route 125 on the south, and an unnamed drainage on the west. Subunit 5A consists of approximately 95 ac (38 ha) and includes 23 ac (9 ha) of Federal land that is part of the San Diego National Wildlife Refuge Complex, 1 ac (less than 1ha) of land owned by the State, and 71 ac (29 ha) of land owned by local government. This subunit meets our selection criteria as satellite habitat. This satellite habitat subunit supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 5B and 5F. Some of the area occupied by N. fossalis was lost during the construction of State Route 125. The soil from that area was salvaged and is being used to restore other vernal pools in this subunit. Subunit 5A contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5B: Otay River Valley. Subunit 5B is located in the City of Chula Vista and unincorporated San Diego County. This subunit is loosely bounded by Olympic Parkway on the north, a housing development on the east, and a landfill to the southwest. Subunit 5B consists of 24 ac (10 ha) of private land and meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5A and 5H. Subunit 5B contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5C: Otay Mesa. Subunit 5C is located on the eastern portion of Otay Mesa, directly northwest of and adjacent to the George F. Bailey Detention Facility at the terminus of Alta Road. Subunit 5C consists of 26 ac (11 ha) of State and local governmentowned land, and 16 ac (7 ha) of private land, and it meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5G and 5I. Subunit 5C contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5F: Proctor Valley. Subunit 5F is located between the unincorporated communities of Eastlake and Jamul in San Diego County. This subunit is located along Proctor Valley Road in Proctor Valley. Subunit 5F consists of approximately 88 ac (36 ha) and includes 51 ac (21 ha) of land owned by the City of San Diego and 37 ac (15 ha) of private land. Subunit 5F meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5A and 5G. The vernal pools in this subunit occur in Proctor Valley on a flat area that is slightly elevated from the stream channel that runs through this valley. The vernal pools in this subunit to the west of Proctor Valley Road are severely impacted by OHV use, but the vernal pools to the east of Proctor Valley road remain relatively intact. Subunit 5F contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or OHV use) that occur in the vernal pool basins.  Subunit 5G: Otay Lakes. Subunit 5G is located east of the City of Chula Vista in San Diego County. This subunit is loosely bounded by Lower Otay Reservoir to the north and west and by the slopes of Otay Mountain to the southeast. Subunit 5G consists of 140 ac (57 ha) of land owned by State or local governments and meets the selection criteria as satellite habitat because this location supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5F and 5I. The vernal pool complexes in this subunit are located on the flat areas to the south of Lower Otay Reservoir. Subunit 5G contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5H: Western Otay Mesa vernal pool complexes. Subunit 5H is located within the Otay Mesa Community planning area of the City of San Diego. Subunit 5H consists of approximately 139 ac (56 ha) that includes 41 ac (17 ha) of land owned by local governments and 98 ac (40 ha) of private land. Subunit 5H and Subunit 5I encompass the core habitat on Otay Mesa. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 5G and 5I. This subunit contains several mesa-top vernal pool complexes on western Otay Mesa (Bauder vernal pool complexes J 2N, J 2S, J 2W, J 4, J 13N, J 13S, J 14, J 33, J 34 as in Appendix D of City of San Diego, 2004). Subunit 5H contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or residential and commercial development) that occur in the vernal pool basins.  Subunit 5I: Eastern Otay Mesa vernal pool complexes. Subunit 5I is located in the City of San Diego. This subunit contains several mesa top vernal pool complexes on eastern Otay Mesa. Subunit 5I consists of 221 ac (89 ha) of private land. Subunit 5I and Subunit 5H encompass the core habitat on Otay Mesa. As core habitat, Subunit 5I contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 5B and 5H. This subunit contains several mesa-top vernal pool complexes on eastern Otay Mesa (Bauder vernal pool complexes J 22, J 29, J 30, J 31N, J 31S as in Appendix D of City of San Diego, 2004 and Service GIS). Subunit 5I contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or residential and commercial development) that occur in the vernal pool basins.

Unit 6: Riverside Management Area. Unit 6 is located in western Riverside County and consists of three subunits totaling 5,477 ac (2,217 ha). This unit contains 1,504 ac (609 ha) of land owned by the State of California’s Department of Fish and Game and 3,973 ac (1,608 ha) of private land. Subunit 6A: San Jacinto River. Subunit 6A is generally located along the San Jacinto River near the cities of Hemet and Perris in Riverside County. This subunit is loosely bounded by Mystic Lake on the northeast and by the Perris Airport on the southwest. Subunit 6A consists of approximately 4,312 ac (1,745 ha), including 1,504 ac (609 ha) of land owned by State or local governments and 2,808 ac (1,136 ha) of private land. Subunit 6A encompasses core habitat along the San Jacinto River. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 6B and 6C. This subunit consists of seasonally flooded alkali vernal plains that occur along the San Jacinto River. Subunit 6A contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping or flood control) that occur in the vernal pool basins and associated watershed area. Subunit 6B: Salt Creek Seasonally Flooded Alkali Plain. Subunit 6B is located near the City of Hemet and west of the Hemet-Ryan Airport in Riverside County. This subunit is loosely bounded by Devonshire Avenue on the north, the boundary for the City of Hemet on the east, train tracks on the south, and lowlying hills on the west. Subunit 6B consists of 930 ac (376 ha) of private land that encompasses the core habitat along the Upper Salt Creek drainage west of the City of Hemet. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 6A and 6C. This subunit consists of seasonally flooded alkali vernal plains not subject to U.S. Army Corps of Engineer jurisdiction. Subunit 6B contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping, grazing, flood control, or discing for vegetation control) that occur in the vernal pool basins and associated watershed area. Subunit 6C: Wickerd and Scott Road Pools. Subunit 6C is located in the City of Menifee in Riverside County, California. This subunit is loosely bounded by low lying hills north of Garbani Road on the north, Briggs Road on the east, Scott Road on the south, and Menifee Road on the west. Subunit 6C consists of 235 ac (95 ha) of private land. This subunit meets the selection criteria as satellite habitat because this location supports a stable occurrence of Navarretia fossalis and provides potential connectivity among occurrences of N. fossalis in Subunits 6A, 6B, and with Subunit 6D that the Service is excluding under section 4(b)(2) of the Act (see Application Section 4(b)(2) of the Action section). This subunit consists of two large vernal pools. Subunit 6C contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping, residential or agricultural development, discing for vegetation control, or maintenance of existing pipelines) that occur in the vernal pool basins and associated watershed area.

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the primary constituent elements (PCEs) for Navarretia fossalis consist of three components:

(i) PCE 1—Ephemeral wetland habitat. Vernal pools (up to 10 ac (4 ha)) and seasonally flooded alkali vernal plains that become inundated by winter rains and hold water or have saturated soils for 2 weeks to 6 months during a year with average rainfall (i.e., years where average rainfall amounts for a particular area are reached during the rainy season (between October and May)). This period of inundation is long enough to promote germination, flowering, and seed production for Navarretia fossalis and other native species typical of vernal pool and seasonally flooded alkali vernal plain habitat, but not so long that true wetland species inhabit the areas.

(ii) PCE 2—Intermixed wetland and upland habitats that act as the local watershed. Areas characterized by mounds, swales, and depressions within a matrix of upland habitat that result in intermittently flowing surface and subsurface water in swales, drainages, and pools described in PCE 1.

(iii) PCE 3—Soils that support ponding during winter and spring. Soils found in areas characterized in PCEs 1 and 2 that have a clay component or other property that creates an impermeable surface or subsurface layer. These soil types include, but are not limited to: Cieneba-Pismo-Caperton soils in Los Angeles County; Domino, Traver, Waukena, Chino, and Willows soils in Riverside County; and Huerhuero, Placentia, Olivenhain, Stockpen, and Redding soils in San Diego County.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one of more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Special management considerations or protection are required within critical habitat areas to address threats. Management activities that could ameliorate these threats include (but are not limited to) fencing Navarretia fossalis occurrences to prevent soil compaction and providing signage to discourage encroachment by hikers, cattle, sheep, and OHV activity; control of nonnative plants using methods shown to be effective; guiding the design of development projects to avoid impacts to N. fossalis habitat; enacting local ordinances to prohibit manure dumping; and restoring and maintaining natural hydrology and floodplain dynamics of watersheds associated with N. fossalis occurrences where feasible. These management activities will protect the PCEs for the species by reducing soil compaction to help maintain an impermeable surface (PCE 3) that supports ephemeral wetland habitat (PCE 1), which is needed to promote germination, flowering, and seed production for N. fossalis. Additionally, management of critical habitat lands will help maintain both the wetland and upland habitat that acts as the local watershed and provides intermittent flowing water on the surface and subsurface (PCEs 2 and 3).

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (NatureServe, 2010)

**Lifespan**

Adult: 1 year (USFWS, 2010)

**Breeding Season**

Adult: May to June (USFWS, 2010)

**Reproduction Narrative**

Adult: Navarretia fossalis (spreading navarretia), a member of the Polemoniaceae (phlox family), is a low, mostly spreading or ascending annual plant. Plants usually flower in May and June because vernal pools must be devoid of standing water before plants begin to flower. Navarretia fossalis has a low pollen to ovule ratio, suggesting there is frequent self-pollination (Spenser et al. 1998, p. 81; D. Boose, Gonzaga University, pers. comm. 2008). Outcrossing, rather than self-pollination, could be advantageous for many vernal pool specialists because it provides a way to better adapt and evolve to the changing conditions of vernal pool habitat through the recombination of beneficial genes (Spenser et al. 1998, p. 81). (USFWS, 2010)

**Habitat Type**

Adult: Palustrine and terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Grassland/herbaceous, playa/salt flat, vernal pools (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Dependent on the ephemeral inundation cycle found in vernal pool habitat and playa; temperature and moisture likely affect timing of germination; fruit absorbs water and expand to break open the fruit after rain (USFWS, 2010)

**Geographic or Habitat Restraints or Barriers**

Adult: Requires areas that are ephemerally wet in winter and spring but dry in summer and fall; vernal pools range in size from 10 to 164 feet wide (USFWS, 2010)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2010)

**Habitat Narrative**

Adult: Navarretia fossalis is typically found in vernal pool (seasonal depression wetlands) habitat, particularly in Los Angeles and San Diego Counties. In western Riverside County, however, N. fossalis is associated with seasonally flooded alkali vernal plain habitat that includes alkali playa (highly alkaline, poorly drained), alkali scrub, alkali vernal pool, and alkali annual grassland components. Vernal pools form in swales, shallow drainages, and depressions that are part of an undulating landscape where soil mounds are interspersed with basins, all above water-impervious soil layers. The hydrologic regime in western Riverside County, however, is unique. Navarretia fossalis here is associated with alkali soils series (Bramlet 1993, p. 1; USFWS 1994, p. 64812), which facilitate a hydrologic regime for this habitat involving sporadic flooding in combination with slow drainage on the alkaline soils. The listing rule states that Navarretia fossalis can also occur in ditches and other artificial depressions often associated with degraded vernal pool habitat (USFWS 1998b, p. 54978; Moran 1977, p. 155). Pools range in size from 10 to 164 feet (3 to 50 meters) across (Zedler 1987, p. 1). Navarretia fossalis abundance also varies from year to year depending on precipitation and the inundation/drying time of the vernal pool. Navarretia fossalis is dependent on the ephemeral inundation cycle found in vernal pool habitat and playas, but may also occur in man-made depressions and ditches that have the same hydrological dynamics. For many vernal pool plant species, temperature and moisture affect the timing of plant germination (Myers 1975, p. 67). Although not proven, it is likely that N. fossalis uses these same cues for germination. Most Navarretia species have indehiscent fruit, or fruit with fibers that absorb water and expand to break open the fruit after a substantial rain (Spenser et al. 1998, p. 82). The timing of germination is important so that the plant germinates under favorable conditions in the spring rather than the summer, autumn, or winter. Navarretia fossalis abundance also varies from year to year depending on precipitation and the inundation/drying time of the vernal pool. (USFWS, 2010)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: We have minimal information on the dispersal of Navarretia fossalis seeds. However, we know the seed has a layer that becomes viscous and sticky when wet. The seed could stick to an animal or bird passing through the vernal pool, providing a method of dispersal. On the other hand, theories also suggest the layer helps secure the seed during seed establishment (Sorenson 1986, p. 444). (USFWS, 2010)

***Population Information and Trends***

**Population Trends:**

Long-term trends suggest a decline of >90%, while short-term trends indicate a decline of 50-70% (NatureServe, 2015)

**Number of Populations:**

55 extant occurrences; 17 presumed extant (USFWS, 2023)

**Population Narrative:**

Currently, there are 48 extant occurrences of N. fossalis. It is estimated that greater than 90 percent of the vernal pool habitat in southern California has been lost due to human activities (Bauder and McMillan 1998, Keeler-Wolf et al. 1998 cited in USFWS 2005). Long-term population trends suggest a decline of >90%, while short-term trends indicate a decline of 50-70%. Individual plants numbering 375,000 were estimated at one California occurrence in 1991-1992 and 100,000 individuals at another in 1998; these occurrences, both in Riverside County, are the largest known for the species (USFWS 2005). Other occurrence counts have indicated a range of sizes from 20 to 50,000+ individuals, but overall most occurrences outside the two largest are believed to be relatively small (< 1,000) (USFWS 2005). The total California population might be around 500,000-600,000 individuals in a wet year, but given that this species is an annual and that single sites are known to vary greatly in population size due to year-to-year variations in precipitation and temperature (USFWS 2005), estimates of plant numbers based on short-term data should be used very cautiously. (USFWS, 2010; NatureServe, 2015). In 2009, of 51 occurrences that were examined, 48 occurrences were considered extant. This included 17 occurrences that had not been known at listing, 12 occurrences where suitable habitat remained but the species had not been located during surveys, and 7 occurrences that had not been surveyed since listing. The 2009 review did not include 9 occurrences in Baja California, or 12 occurrences that had not been seen since prior to listing. In addition, the 2009 review considered the occurrences at Cruzan Mesa, the San Jacinto River, Upper Salt Creek, and Otay Lakes each to be single populations, while this review includes multiple occurrences at those locations. Currently, of 100 Navarretia fossalis populations we examined, 55 are extant, 17 are presumed extant, 6 are possibly extirpated, and 22 have been extirpated. Of the 22 extirpated occurrences, 12 had not been seen since prior to listing, though two of these (EO 2, 58) were included as extant in the 2009 review. In addition, 3 were in Baja California, and 2 were extirpated in the early 2000s (EO 77, EO 1) but the adjacent mitigation areas (EO 20, 53) were addressed as extant in the 2009 review. Finally, 3 were documented as extirpated in the 2009 review; However, one of these (EO 69) was observed in 2020 but has since been extirpated. Two additional populations (EO 46, EO 76) have been extirpated in the time since the last review (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Urbanization (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The threat of development has lessened since listing due to a limited amount of permanent protection and some conservation measures now in place, although urbanization is still a predominant threat to N. fossalis. Components of urbanization include the direct loss of habitat from development, alteration of hydrology, transportation and flood control projects, grading, pipeline construction, and OHV use. The population of Riverside County is predicted to

grow 46.3 percent from 2000 to 2020 while Los Angeles and San Diego Counties are predicted to grow 20.2 and 14.6 percent, respectively (California Department of Finance 2007, Table 2). These predictions suggest urbanization pressures will continue to rise within the range of Navarretia fossalis, posing an increasing threat to remaining populations near growing cities in southern California. (USFWS, 2010)

**Stressor:** Direct habitat loss to development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since listing, three (possibly four) Navarretia fossalis occurrences were extirpated by development (S. Brown, U. S. Fish and Wildlife Service, pers. obs. 2008). Wickerd Pool in Riverside County was affected by the installation of a water pipeline across the occurrence (USFWS 2001a, p.1). Also, 9 of the 48 occurrences are proposed for development (San Jacinto River, Stetson-Warren/Hemet, Menifee, Scott Pool, Date Street, Los Caballos, Pacific Street, Montgomery Field, J 29-30). Development plays a role in the fragmentation and habitat isolation of Navarretia fossalis. Habitat fragmentation within Navarretia fossalis occurrences or groups of nearby occurrences may also disrupt hydrological systems and create barriers to dispersal. The Service encourages project proponents to develop projects that avoid isolating vernal pools or dividing occurrences into ecologically separate fragments, and to configure preserved or restored sites adjacent to and continuous with existing preserve areas. Whenever vernal pools in a complex are impacted by development, some degree of fragmentation occurs within and among complexes. Fragmentation and associated impacts to hydrology and dispersal continue to threaten N. fossalis throughout its range. Since listing, many Navarretia fossalis occurrences impacted by development have been restored or partially restored. These restorations help offset impacts from development of vernal pool habitat. The threat to N. fossalis habitat from urbanization has decreased since listing, although habitat loss from development is an ongoing predominant threat. (USFWS, 2010)

**Stressor:** Agricultural Conversion (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Conversion of land for the purposes of grazing or farming was cited in the listing rule as a threat to Navarretia fossalis, especially in Riverside County (USFWS 1998b, p. 54985). These factors continue to threaten the San Jacinto River and flood plain in Riverside County, but are not threats in San Diego or Los Angeles Counties (Table 2). Five occurrences in Riverside County are documented as affected by agricultural practices (San Jacinto River, Stowe Pool, Menifee Pool, Wickerd Pool, and Johnson Ranch). (USFWS, 2010)

**Stressor:** Discing (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Discing for weed abatement, fire suppression, and dry-land farming were listed as threats to Navarretia fossalis in the final listing rule (USFWS 1998, 63 FR 54984). Discing turns up the soil and inhibits N. fossalis from germinating. It can destroy vernal pools and affect the long-term viability of N. fossalis. Vernal pools are frequently selected as sites to implement fire

prevention measures, such as discing, because they are in open areas near development and often support a considerable cover of highly flammable, nonnative grass. Since listing, discing along roads and around development for weed abatement or fuel modification has continued. Discing for agricultural conversion is most abundant in Riverside County, where often such land is considered historically agricultural and therefore is exempt from many of the conservation measures in the Western Riverside County Multiple Species HCP (Western Riverside County MSHCP). Navarretia fossalis habitat was observed to be disced at Stowe Pool, historically one of the most abundant occurrences of the species (Brown, pers. obs. 2006a). Discing continues to be a threat to N. fossalis. (USFWS, 2010)

**Stressor:** Manure dumping (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although not identified at the time of listing, manure dumping has become a threat to the longterm viability of Navarretia fossalis in some areas of western Riverside County. This threat is especially evident along the San Jacinto River, which harbors the most extensive occurrences of N. fossalis (Roberts 2005, p. 4 and Attachment A; Brown, pers. obs. 2006b; F. Roberts, USFWS, pers. comm. 2008; A. Braswell, pers. obs. 2008; E. Kashac, Santa Ana Regional Water Quality Control Board, pers. comm. 2008). The Wickerd Pool occurrence has also been affected by manure dumping. When manure or water that leaches through it washes into the flood plain and river, it changes the pH and the soil composition. This inhibits germination of N. fossalis and increases nutrients, which promotes the growth of invasive nonnative plant species such as Chenopodium spp. (goosefoot), Brassica nigra (black mustard), and Salsola tragus (Russian thistle) (Roberts 2004, p. 7). (USFWS, 2010)

**Stressor:** Alteration of hydrology (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Increased urban runoff and channelized drainage of lands can change the inundation of a pool (USFWS 1998b, pp. 54984-54985). At listing, alteration of hydrology was considered a predominant threat to Navarretia fossalis. Instances of wetlands drainage for purposes of agriculture or development in Riverside County resulted in the loss of N. fossalis populations (USFWS 1998b, p. 54985). The Service considered the remaining wetlands available to N. fossalis as smaller and more vulnerable to the effects of surrounding development than they were earlier in the century. Since listing, there have been five accounts (San Jacinto River, Scott Pool, Mesa de Burro, Pacific Street, and Sweetwater High School) of direct alteration of hydrology to vernal pools or complexes that support Navarretia fossalis. Development can alter the timing, frequency, and duration of vernal pool inundation as well as water temperature. Modifications to the uplands surrounding a vernal pool can negatively affect the pool’s hydrology, even if such modifications occur outside the pool’s surface watershed. For example, grading cuts near pools can accelerate the flow of water out of the subsoil (Bauder 1986b, p. 210). As such, graded slope-cuts adjacent to the watersheds of depressional features may result in “leakage” of water out of the watersheds. Such grading of the watershed was observed at the Mesa de Burro occurrence when a road adjacent to the vernal pool was graded in 2003 without authorization (D. Stadlander, U. S. Fish and Wildlife Service, pers. obs. 2003). Disturbance may also allow invasive plants or non-vernal pool species to occupy the pools and compete with vernal pool

plant species (Bauder 1986a, pp. 21-22), or may also alter the composition of native species of a vernal pool. As an obligate wetland species, Navarretia fossalis depends on compatible, seasonal inundation. Navarretia fossalis is vulnerable to changes in water levels and periods of inundation. Although some watersheds have been conserved and instances of runoff avoided through section 7 consultations, alteration of hydrology remains a predominant threat to many N. fossalis occurrences. (USFWS, 2010)

**Stressor:** Transportation and flood control projects (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The listing rule identified SR 125 construction on Otay Mesa as a project that could impact Navarretia fossalis habitat. This transportation project is completed and directly impacted the occurrences at Sweetwater Reservoir and J 29-30 vernal pool complexes. State Route 11 is planned southeast of SR 125 on Otay Mesa. Though habitat is present, N. fossalis was not detected and Caltrans anticipates future potential indirect impacts in the form of edge effects to occurrences if they are discovered in the area (USDOT and Caltrans 2008, pp. 3.20-11-3.20-15). Scott Road in Riverside County was also widened, threatening but not destroying the Scott Pool occurrence (Terra Nova 2007, Exhibit 6). The San Jacinto River Improvement Project is an ongoing proposal identified at the time of listing that is not yet complete. The proposed project will affect some sections of N. fossalis habitat along the San Jacinto River, and preserve other sections (Dudek and Associates 2003, pp. 7-59). State Route 79 was proposed to run through the Upper Salt Creek occurrence in Hemet prior to the listing of N. fossalis, but now an alternate route is being proposed. Through mitigation and avoidance measures, the Service believes that transportation and flood control projects are not a predominant threat to N. fossalis at this time. (USFWS, 2010)

**Stressor:** Grading (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The grading of vernal pool habitat was identified as a threat to Navarretia fossalis in the listing rule (USFWS 1998b, p. 57984). Grading can change vernal pool hydrology, turn up the soil, and destroy the habitat and vegetation. Since listing, Service files indicate that three occurrences have been graded: 1) the Cruzan Mesa occurrence; 2) the Arjons area, which is along the east edge of the Carroll Canyon Preserve occurrence; and 3) the aforementioned grading at the Mesa de Burro occurrence (Table 2). Since grading continues to occur, we still consider it a threat to N. fossalis. (USFWS, 2010)

**Stressor:** Pipeline construction (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A pipeline project was identified as a threat to Navarretia fossalis in the listing rule (USFWS 1998b, p. 54984). Since that time, there have been two cases of pipeline construction through a vernal pool (Table 2). First, a pipeline was run directly through Wickerd Pool in Riverside County with no mitigation for the effects of the project (USFWS 2001b, p.1). Second, a proposed storage pond and pipeline for a recycled water storage system would destroy 200 acres

(81 hectares) of land on the San Jacinto River Wildlife Area (USFWS 2008, p.1). Since listing, pipeline construction has affected the habitat of N. fossalis without mitigation or avoidance of vernal pools and we still consider pipeline construction a threat. (USFWS, 2010)

**Stressor:** Off-highway vehicles (OHV) (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, OHV use was described as an ongoing threat to Navarretia fossalis in Riverside and San Diego Counties (USFWS 1998b, p. 54984). This type of activity may alter the hydrology, degrade habitat, and compromise the existence of N. fossalis within vernal pools (e.g., crush plants). Currently, OHV impacts fall into three categories: recreational (often illegal) on private or public property, Border Patrol activities, and emergency response actions. Since listing, OHV activity has impacted the majority of pools in the Otay Mesa region, and is documented in 12 pools in San Diego County and 1 pool in Los Angeles County (Table 2). Most of these accounts are from recreational vehicles trespassing on protected property, despite efforts of landowners to deter illegal trespass. However, vernal pools at Otay Mesa are threatened by OHV use associated with Border Patrol activities (City of San Diego 2006, pp. 136-140). These roads are often used and expanded by recreational OHV users. Despite attempts to deter this activity using fencing and signage, off-highway vehicle activity remains a threat to N. fossalis. To a lesser degree, OHV use for emergency response (e.g., fire suppression and aviation emergencies) and law enforcement actions may impact Navarretia fossalis habitat. Many vernal pools occur within areas that are prone to fire, such as the vernal pools at Otay Lakes that burned in the 2003 Otay Fire. Fire suppression activities may impact vernal pools and N. fossalis due to vehicle and people/equipment movement through pools or creation of firebreaks. Additionally, aviation emergency response may occur at vernal pools near the Ramona, Montgomery Field, and Marine Corps Air Station (MCAS) Miramar airports. Today, OHV use remains a threat to Navarretia fossalis, especially from Border Patrol and recreational activities near vernal pools on Otay Mesa. Installation and maintenance of fencing and signage are needed to help protect N. fossalis habitat from the impact of OHV users. (USFWS, 2010)

**Stressor:** Grazing (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sheep herbivory and cattle grazing were reported at listing as threats to Navarretia fossalis under Factor A, but are treated under Factor C in this 5-year review. There has been only one reported incident of grazing affecting N. fossalis since listing. Sheep grazed on Stowe Pool and reportedly ate the flowering heads of N. fossalis and trampled the pool (Roberts, pers. comm. 2005). Disease and predation are not considered wide spread or rangewide threats for N. fossalis. (USFWS, 2010)

**Stressor:** Competition with invasive non-native plants (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The listing rule stated that nonnative species of grasses and forbs invade many plant communities often as an indirect result of habitat disturbance (USFWS 1998b, p. 54988). At

listing, many vernal pools on Otay Mesa or in the City of San Macros were dominated by the nonnative Lolium perenne (perennial ryegrass). The ryegrass displaced Navarretia fossalis in many vernal pools because ryegrass is more tolerant of inundation. The listing rule cited another nonnative grass, Crypsis schoenoides (swamp pricklegrass), as replacing N. fossalis in the San Jacinto River Wildlife Area in Riverside County (USFWS 1998b, pp. 54988-54989). Approximately 60 percent (29 of 48) of the existing N. fossalis occurrences are threatened by invasive nonnative plants. Invasive nonnative plants that may impact Navarretia fossalis are divided into three groups: (1) upland species with less tolerance for inundation, (2) plants with inundation tolerance comparable to native vernal pool species, and (3) marsh or wetland species that require a long inundation period (Bauder 1996, p. 2). Altered hydrology can change the inundation period of an area and indirectly affects species that are less or more water tolerant than native vernal pool species, resulting in elimination from or invasion into vernal pool habitat (Bauder 1986b, p. 210). Alternatively, if natural hydrology persists, the number of nonnatives able to invade may be limited by the inundation period (Bauder 1996, p. 2). Development and OHV use (both discussed under Factor A), human access, and disturbance effects (see below) typically alter the hydrology of vernal pools. Additionally, manure dumping can change soil chemistry and facilitate invasives in normally unfavorable areas. These alterations lead to a higher disturbance level and therefore a greater likelihood of invasion by nonnative species (Bauder 2005, p. 2134). Depending upon conditions, certain invasive nonnative plants, such as the grasses discussed above, may replace Navarretia fossalis. Therefore, we consider invasive nonnative plants to be a continuing threat to N. fossalis. (USFWS, 2010)

**Stressor:** Human access and disturbance effects (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Separation of Navarretia fossalis occurrences through habitat loss and fragmentation is often accompanied by the introduction or exacerbation of indirect effects associated with human access, or disturbance associated with adjacent development. Examples include trash dumping, trampling, and nonnative plant invasions. In the listing rule for N. fossalis, trash dumping, trampling, and invasive nonnative plant species were cited as threats to the species (USFWS 1998b, p. 54988). All known occurrences of Navarretia fossalis may potentially be affected by human access and disturbance impacts from surrounding development (Table 2). Since listing, impacts associated with adjacent development have been documented to occur at 35 (71 percent) of the N. fossalis occurrences (Table 2). For example, asphalt was dumped at the Upham occurrence in San Macros during road repairs in 2001 (J. Upham, owner, pers. comm. 2001). This small property is completely surrounded by development and is highly impacted by human-related disturbance. Pedestrians can introduce invasive nonnative plants that result in altered hydrology and competition with native plants. Protective fencing is used in many conserved occurrences to protect vernal pool complexes. Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still pose a predominant threat to N. fossalis. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The listing rule stated that drier conditions and drought are threats to Navarretia fossalis, which relies on seasonal rainfall and the pooling of water. Drier conditions physiologically stress the species and reduce its germination and survival rates (USFWS 1998b, p. 54989). Additionally, other threats may have an increased impact when combined with impacts from climate change. Data from 1986 to 1992 indicate drought was related to a decrease in the abundance of N. fossalis (USFWS 1998b, p. 54989; Table 1). However, there is no evidence to suggest that this was caused by climate change rather than normal climatic cycles. Currently, drier conditions and drought remain a threat to all occurrences of Navarretia fossalis. Predictions for California indicate prolonged drought and other climate-related changes will continue in the future (e.g., Field et al. 1999, pp. 8–10; Lenihen et al. 2003, p. 1667; Hayhoe et al. 2004, p.12422; Breshears et al. 2005, p. 15144; Seager et al. 2007, p. 1181; IPCC 2007, p. 9). In habitat such as vernal pools that is isolated and dependent on certain hydrological regimes, these climatic changes are expected to become even more dramatic and intense (Graham 1997). It is expected that climate change will alter the hydrology of the region, and therefore threaten the existence of vernal pool habitat and associated species such as Navarretia fossalis (Bauder 2005, pp. 2133-2134). While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including N. fossalis) or sites at this time. However, it is possible that drying could be expected to adversely affect the long-term viability of N. fossalis in its habitat. (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8

**Delisting Criteria:**
1. All the existing vernal pools and their watersheds should be secured from further loss and degradation in a configuration that maintains habitat function and viability (as determined by prescribed research tasks). (USFWS, 1998)

2. Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased. (USFWS, 1998)

3. Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. (USFWS, 1998)

**Recovery Actions:**
- Design and establish a vernal pool habitat preserve system within each Management Area that will maximize the ecological distribution for each listed and proposed species, minimize risk of habitat loss, retain genetic differentiation, and provide the opportunity for expansion of populations. (USFWS, 1998)
- Within each Management Area, reestablish vernal pool habitat to historic structure and composition to increase genetic diversity and population stability. (USFWS, 1998)
- Within each Management Area, rehabilitate and enhance secured vernal pool habitats and their constituent species. (USFWS, 1998)
- Manage protected habitat. (USFWS, 1998)
- Monitor protected habitat and listed species. (USFWS, 1998)

- Coordinate with Riverside County and city governments to enact ordinances banning manure dumping in areas containing sensitive species, such as the San Jacinto River flood plain. Such a measure could reduce threats and meets Criteria 1 and 2 for the Recovery Plan. (USFWS, 2010)
- Determine the breeding system, distribution of genetic diversity of Navarretia fossalis, and best management practices to maintain genetic diversity within the species. This would allow a better understanding of the methodology needed to meet Criterion 4. (USFWS, 2010)
- Consider revising the Recovery Plan by incorporating new information and addressing issues discussed in Recovery Criteria section of this review. Consider revising recovery criteria to be threats-based and to include quantifiable thresholds to down list and delist. Additionally, areas of high value to the species should be identified and preserved. (USFWS, 2010)
- In order to analyze trends in abundance, standardize methods for sampling abundance of Navarretia fossalis. Use quantitative indices in data collection protocol. Any empirical approach in methodology will prove a more reliable method to analyze population data required in Criteria 3 and 4. (USFWS, 2010)
- Work with partners to help conserve Navarretia fossalis, by conducting surveys of all occurrences within the next 5 years to have more information (abundance, spatial distribution, and threats) about the status of the species. Recovery Plan Criteria 3 and 4 require that populations are monitored and stabilized. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS These actions are intended to help reduce impacts from threats to Navarretia fossalis over the next 5 years. We recognize that cooperation and coordination with our partners will aid future restoration efforts for this species. The recommended actions listed below includes actions from the past 5-year review and new actions that are relevant to the conservation of N. fossalis: 1. Work with partners to identify opportunities for conservation of Navarretia fossalis occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire Navarretia fossalis habitat. 2. Survey or monitor occurrences to provide more information about the status of the species (abundance, spatial distribution, and threats) and assess management effectiveness. Recovery Plan Criteria 3 and 4 require that populations are monitored and stabilized. a. Standardize methods for sampling abundance of Navarretia fossalis to analyze abundance trends. Use quantitative indices in data collection protocols (Supports Recovery Plan Criteria 3 and 4). 3. Adaptively manage vernal pool habitat to maintain, enhance, or restore habitat and maintain population viability over time. a. Manage nonnative plants in vernal pool habitat. Coordinate with partners to develop best practices for nonnative species prevention and eradication to benefit Navarretia fossalis habitat. 4. Maintain or enhance Navarretia fossalis genetic diversity. Conduct a population genetics study to characterize genetic variation and structure in N. fossalis and determine the species’ breeding system. Based on study results, develop best management practices to maintain genetic diversity within the species (Supports Recovery Plan Criterion 4). 5. Work with partners in Baja California, Mexico to survey additional areas for Navarretia fossalis and identify conservation opportunities (USFWS, 2023).

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# SPECIES ACCOUNT: *Navarretia leucocephala ssp. pauciflora (=N. pauciflora)* (Few-flowered navarretia)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A much-branched, spreading annual herb, about 1-4 dm tall, with linear, or linear-lobed, leaves. The inflorescence is a cluster of 2-15 blue or white flowers, subtended by long, spiny, leaf-like bracts. Blooms May-June. (NatureServe, 2015)

**Current Range**

Volcanic ash vernal pools in Lake County, California. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowering occurs from May to June (USFWS, 2023)

**Reproduction Narrative**

Adult: Flowering occurs from May to June and the fruit is a papery capsule that breaks open only when wet. Few-flowered navarretia has fewer flowers per head and fewer lobes on the outer bracts than the closely related many-flowered navarretia (Navarretia. leucocephala ssp. plieantha) which is also federally-listed as endangered. However, some plants exhibit characteristics intermediate between the few-flowered navarretia and the many-flowered navarretia and cannot be assigned definitively to either subspecies (USFWS, 2023).

**Habitat Type**

Adult: Vernal Pools (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Vernal Pools (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (Inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Vernal pools with a volcanic ash substrate in chaparral, grassland, or mixed coniferous forest communities. (NatureServe, 2015)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

10 (USFWS, 2023)

**Population Size:**

1000 - 2500 individuals (NatureServe, 2015)

**Adaptability:**

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

**Population Narrative:**

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015). Currently, the Diversity Database reports ten presumed extant occurrences of the species; eight in Lake County and two in Napa County (see Table 1; Diversity Database 2022). Two occurrences (occurrence #11 and #12) in Lake County have been added to the Diversity Database since the 2008 status review; these occurrences are within the known range of the species and do not change our understating of the species distribution. Occurrence 11 is located along Highway 29 between two previously identified occurrences (occurrence #4 and #5). This occurrence is known from an observation in 2003 and a Caltrans survey in 2011 (Diversity Database 2022). Occurrence 12 was added to the Diversity Database for the Breems Lake historical record. This occurrence is mapped to a general area at the west base of Mount Konocti as the exact location of the historical observation remains unknown (Diversity Database 2022). As mentioned in the 2008 5-year review, the historical records have extremely vague locality descriptions and may represent other already known sites by different names (Service 2008, p. 12). It is also possible that few-flowered navarretia have been extirpated from the historical occurrences (occurrence #3, #10, and #12). There is no new information regarding the Cobb area locality, which is discussed in the 2008 status review but is not reported in the Diversity Database, or the Loch Lomond Vernal Pool Ecological Reserve (occurrence #1) and Boggs Lake (not reported in the Diversity Database) occurrences, which may contain many-flowered navarretia or an intermediate (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Climate change (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool species. Cooling and drying trends could adversely affect fewflowered navarretia through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions with higher precipitation could increase the area of vernal pools, which would not necessarily be a negative effect because increased vernal pool area could increase available habitat for few-flowered navarretia. There could also be increased competition from nonnative plants. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most

appropriate to ensure the sustainability of vernal pool species, including few-flowered navarretia (USFWS, 2008).

**Stressor:** Habitat destruction and modification (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats to the habitat of few-flowered navarretia include alteration of hydrology, effects from road maintenance activities, agriculture land conversion, construction of a stock pond, off-road vehicle use, inappropriate grazing regimes, and competition from invasive weedy plant species (USFWS, 2008).

**Stressor:** Nonnative plants (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition from invasive plant species continues to pose a threat to this species. The localities at Hesse Flat and Manning Flat have been reported to be threatened by invasive plant species such as yellow star thistle (Centaurea solstitialis). Although specific information regarding adverse effects from invasive plant species is not available for all sites, it is likely that many of the localities of few-flowered navarretia are currently threatened by invasive plants to some degree. Further research and monitoring are necessary to determine the degree that this species is threatened by non-native invasive plant species (USFWS, 2008).

**Stressor:** Stochastic events (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small numbers of localities makes it difficult for this species to persist while sustaining the impacts from competition from nonnative plant species, intensive grazing, changes in hydrology, adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance environmental disturbances. If a locality of fewflowered navarretia has several consecutive years of poor rainfall, intensive grazing, changes in hydrology from adjacent development, or intense competition from other plant species, it is possible that the locality will become extirpated. Populations that decline to zero may not always be capable of rebounding from the soil seed bank and the population is likely to become extirpated (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 3

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the few-flowered navarretia. Some of these recommendations have already been discussed in the Recovery Plan for Vernal Ecosystems of California and Southern Oregon and the 2008 status review (Service

2005, pp. III-5–III-93; Service 2008, pp. 18–19) and remain valid. 1. Erosion control measures should be implemented at Manning Flat to prevent further erosion of this site and to prevent the destruction of the few-flowered navarretia locality found there. 2. The majority of known localities of this species are on private land and not protected. Preservation of suitable habitat in core areas should be pursued to preserve known localities that are currently not protected. 3. Once additional sites are protected, management plans should be prepared for the protected sites. Results from standardized monitoring discussed in item 4, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. 4. Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the Navarretia leucocephala group. 5. Regional vernal pool working groups should be created for the Lake-Napa Vernal Pool Region where few-flowered navarretia is known to occur to aid with monitoring and management efforts. 6. Comprehensive mapping of Lake County and Napa County vernal pool habitat should be completed to better understand the amount of suitable habitat available for the species within the recovery core areas. 7. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the few-flowered navarretia and develop stepdown success parameters, if appropriate, that reflects the species' life history and narrow range to help us better understand the status of the species (USFWS, 2023).

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# SPECIES ACCOUNT: *Navarretia leucocephala ssp. plieantha* (Many-flowered navarretia)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 06/18/1997; California/Nevada (Region 8) (USFWS, 2015)

**Physical Description**

Navarretia leucocephala ssp. plieantha forms mats 5 to 20 cm (2.0 to 7.9 in) across and 1 to 3 cm (0.4 to 1.2 in) high. The stems have a peeling, white surface and are highly branched. Stem thickness is 0.8 to 1.4 mm (0.03 to 0.06 in) and is more or less uniform throughout its length. The leaves are 3 to 4 cm (1.2 to 1.6 in) long and are either entire or have a few thread-like lobes. Flower heads are 1.5 to 2 cm (0.6 to 0.8 in) across and contain between 10 and 60 pale blue flowers. Each flower in the head is 5 to 6 mm (0.20 to 0.24 in) long. The capsule and seeds are similar to those of N. leucocephala ssp. pauciflora; each fruit may contain as many as three seeds (Mason 1946, Day 1993b). (USFWS, 2005)

**Taxonomy**

The name first assigned to many-flowered navarretia was Navarretia plieantha. The type locality for the species is Boggs Lake, in Lake County (Mason 1946). Day (1993a) later reduced many-flowered navarretia to the rank of subspecies, under the name Navarretia leucocephala ssp. plieantha. As explained in the species account for Navarretia leucocephala ssp. pauciflora, some populations of Navarretia consist of individuals intermediate in characteristics between two subspecies. Dr. Day (in litt. 1997) has distinguished two types of intermediate specimens, which others have identified as N. leucocephala ssp. plieantha. One group is intermediate between N. leucocephala ssp. pauciflora and N. leucocephala ssp. plieantha, and the other is intermediate between N. leucocephala ssp. plieantha and N. leucocephala ssp. bakeri (Baker’s navarretia). (USFWS, 2005)

**Historical Range**

Typical Navarretia leucocephala ssp. plieantha was known historically only from Boggs Lake (A. Day in litt. 1993, 1997). The other reported occurrences include six sites with plants that are intermediate between N. leucocephala ssp. plieantha and other subspecies, and two sites where Dr. Alva Day does not have access to specimens to confirm the identity of the plants (A. Day in litt. 1993, 1997). Three historical occurrences in Lake County (Loch Lomond, Mount Hannah Lodge, and Siegler Springs Road) have plants intermediate between N. leucocephala ssp. pauciflora and N. leucocephala ssp. plieantha. At least three occurrences in the Santa Rosa area, in Sonoma County, consist of plants intermediate between N. leucocephala ssp. plieantha and N. leucocephala ssp. bakeri (A. Day in litt. 1993, 1997). (USFWS, 2005)

**Current Range**

The five occurrences reported as extant in the final rule (U.S. Fish and Wildlife Service 1997b) were Boggs Lake, Loch Lomond, Mount Hannah Lodge, Siegler Springs Road, and Stienhart Lake, which are in the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998). These occurrences are still believed to be extant, although only three populations have been revisited since 1989 (California Natural Diversity Data Base 2005). (USFWS, 2005)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (USFWS, 2009)

**Breeding Season**

Adult: May to June (NatureServe, 2015)

**Reproduction Narrative**

Adult: Navarretias are an annual herb of the phlox family that bloom from May to June. Each fruit may contain as many as three seeds (Mason 1946; Day 1993b). (USFWS, 2009; NatureServe, 2015)

**Habitat Type**

Adult: Palustrine and terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest/Woodland, temporary pools (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Requires temporary pools or wet ground in forest openings (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: The many-flowered navarretia is extremely rare. This species is found only on substrates of volcanic origin and is dependent on vernal pools, vernal lakes, and swales for survival. Its life history is closely linked to the hydrology of these wetlands. Extant localities of this species are located in Lake and Sonoma counties (USFWS, 2023)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

8 (USFWS, 2023)

**Population Narrative:**

The five occurrences reported as extant in the final rule (U.S. Fish and Wildlife Service 1997b) were Boggs Lake, Loch Lomond, Mount Hannah Lodge, Siegler Springs Road, and Stienhart Lake, which are in the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998). These occurrences are still believed to be extant, although only three populations have been revisited since 1989 (California Natural Diversity Data Base 2005). The typical population of Navarretia leucocephala ssp. plieantha at Boggs Lake has not declined (Baldwin and Baldwin 1991, California Natural Diversity Data Base 2005). (USFWS, 2005). Currently, the Diversity Database reports eight known occurrences of this species: six in Lake County and two in Sonoma County (Diversity Database 2022). All eight occurrences are presumed extant. One occurrence (Occurrence #14) has been identified since the 2009 status review (Diversity Database 2022). This occurrence is located in proximity to other previously known occurrences and is found within the Boggs Mountain Demonstration Garden managed by the California Department of Forestry and Fire Protection. Two of the many-flowered navarretia occurrences are protected within reserves. One of the protected populations occurs at Boggs Lake Ecological Reserve that is co-owned and managed by California Department of Fish and Wildlife and The Nature Conservancy (Diversity Database 2022, occurrence # 1). The second protected population documented in the Diversity Database is at Loch Lomond Vernal Pool Ecological Reserve which is managed by the California Department of Fish and Wildlife (Diversity Database 2022, occurrence #4). The other five documented populations are on private lands (Diversity Database 2022, occurrence #5, 9, 10, 11, 12). Since the 2009 status review, the presence of the species has been verified at five occurrences and recent abundance estimates are available for three of those occurrences. See Table 1 for the most recent occurrence and survey data. Status surveys and updates continue to be infrequent. More monitoring is needed to identify abundance and population trends for many-flowered navarretia throughout its current distribution (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Invasive species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat to Navarretia leucocephala ssp. plieantha at Boggs Lake is infestation by invasive species including Cirsium spp. (thistle), Centaurea spp. (knapweed), and Typha spp. (cattail) (CNDDB 2007). Competition from invasive plant species continues to pose a threat to this species. The localities at Mt. Hannah Lodge and Boggs Lake have been reported to be threatened by invasive plant species (CNDDB 2007) including infestation by invasive Centaurea solstitialis (star thistle) and Taeniatherum caput-medusae (medusahead). Although site specific information regarding adverse effects from invasive plant species is not available, we believe it is likely that many of the localities of Navarretia leucocephala ssp. plieantha are currently threatened by invasive plants to some degree. (USFWS, 2009)

**Stressor:** Off-highway vehicles (OHVs) (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The primary threat to Navarretia leucocephala ssp. plieantha at this site is offhighway vehicles (OHV's) and California Department of Transportation activities next to the preserve (CNDDB 2007). The occurrence is adjacent to State Route 175, where road maintenance activities could still result in the loss of plants. Occasional fence vandalism and vehicle trespass still occur at Loch Lomond (S. Zalusky, Northwest Biosurvey, pers. comm. 2008). (USFWS, 2009)

**Stressor:** Urban lane use (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Plants at Seiglers Springs are threatened by urban land use (CNDDB 2007). (USFWS, 2009)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Pyke 2005). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). However, it is possible that either scenario would result in negative effects to vernal pool species (Pyke 2004; Pyke and Marty 2005). Cooling and drying trends could adversely affect Navarretia leucocephala ssp. plieantha through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions with higher precipitation could increase the area of vernal pools, which would not necessarily be a negative effect because increased vernal pool area could increase available habitat for N. leucocephala ssp. plieantha. There could also be increased competition from nonnative plants. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including N. leucocephala ssp. plieantha. (USFWS, 2009)

**Stressor:** Small numbers of localities/stochastic extinction (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations (e.g., Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). In particular, small numbers of localities makes it difficult for this species to persist while sustaining the impacts from competition from nonnative plant species, intensive grazing, changes in hydrology, adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events or additional environmental disturbance (Goodman 1987; Gilpin and Soule 1988). If a locality of Navarretia leucocephala ssp. plieantha has several consecutive years of poor rainfall, intensive grazing, changes in hydrology from adjacent development, or intense competition from other plant species, it is possible that the locality will become extirpated. (USFWS, 2009)

**Stressor:** Cattle grazing (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats to the Saunders Road locality include cattle grazing, wastewater irrigation, and potential urban development. Additionally, grazing has eliminated many native species (CNDDB 2007). Threats to Shiloh Ranch include grazing, trampling, and urban development (CNDDB 2007). (USFWS, 2009)

**Stressor:** Neonicotinoid pesticides (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In June 2022, the Environmental Protection Agency (EPA) released the final biological evaluation on clothianidin, imidacloprid, and thiamethoxam, a group of insecticides known as neonicotinoids (EPA 2022a, entire; EPA 2022b, entire; EPA 2022c, entire). All three neonicotinoids are registered for use on a variety of agricultural crops, as well as some nonagricultural applications. These three neonicotinoids are highly toxic to terrestrial and aquatic invertebrates but are much less toxic to other vertebrate and plant taxa. The EPA evaluated the effects of labelled use of these neonicotinoids to determine whether they may affect one or more species listed under the Endangered Species Act or their designated critical habitats. The reliance of listed species on invertebrate species as prey or pollinators was considered in the biological evaluations. The EPA determined through moderate evidence that these neonicotinoids are likely to adversely affect (LAA) many-flowered navarretia (EPA 2022a, entire; EPA 2022b, entire; EPA 2022c, entire). The LAA determination means that the EPA reasonably expects that at least one individual animal or plant, among a variety of listed species, may be exposed to the pesticide at a sufficient level to have an effect, which will be adverse. However, the overall importance of pollinating insects for many-flowered navarretia is poorly understood and additional research is needed. The EPA anticipates releasing amended proposed interim decisions in 2023, which will include updates to some of the previously proposed mitigation measures to reduce neonicotinoid exposures for listed species. Mitigation measures will be finalized in the interim decisions, which the EPA expects to release in 2024 and the Service will consider these final mitigations during consultation (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species localities distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Reintroduction and introductions must be carried out and meet success criteria. Additional localities that are detected (and determined essential to recovery goals) are permanently protected. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average

local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2009)

2. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected. Mechanisms are in place to provide for management in perpetuity and long-term monitoring. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria. (USFWS, 2009)

3. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated. (USFWS, 2009)

4. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected. Research necessary to determine appropriate parameters to measure population viability for each species have been completed. (USFWS, 2009)

5. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 14. (USFWS, 2009)

Recovery Priority Number: 3

**Delisting Criteria:**
Same as reclassification criteria.

**Recovery Actions:**

- Recovery actions are not available.
- The majority of known localities of this species are on private land and not protected. Preservation of Zone 1 core areas should be pursued to preserve known localities that are currently not protected. (USFWS, 2009)
- Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the 2005 Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the Navarretia leucocephala group. (USFWS, 2009)
- Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. (USFWS, 2009)
- Regional vernal pool working groups should be created in regions where Navarretia leucocephala ssp. plieantha is known to occur to aid with monitoring and management efforts. (USFWS, 2009)
- Potential habitat should be surveyed for new populations and if located, those populations should be protected. (USFWS, 2009)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the many-flowered navarretia. Some of these recommendations have already been discussed in the Recovery Plan and the 2009 status review (Service 2005, pp. III-5–III-93; Service 2009, p. 19) and remain valid. 1. The majority of known localities of this species are on private land and not protected. Preservation of suitable habitat in the core areas should be pursued to preserve known localities that are currently not protected. 2. Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the N. leucocephala group. 3. Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in recovery criterion 2A, above, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. 4. A regional vernal pool working group should be created for the Lake-Napa Vernal Pool Region where many-flowered navarretia is known to occur to aid with monitoring and management efforts. 5. Comprehensive mapping of Lake County and Sonoma County vernal pool habitat should be completed to better understand the amount of suitable habitat available for the species within the recovery core areas. 6. Potential habitat should be surveyed for new populations and if located, those populations should be protected. 7. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the many-flowered navarretia and develop stepdown success parameters, if appropriate, that reflects the species' life history and narrow range to help us better understand the status of the species (USFWS, 2023).

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# SPECIES ACCOUNT: *Nitrophila mohavensis* (Amargosa niterwort)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A perennial herb. Leaves ovate, small, bright green. Flowers small, inconspicuous, pink, becoming white. (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Known only from the Amargosa River drainage in extreme southeastern Inyo County, California (Reveal, 1989) and from Nye county in bordering Nevada. (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 5/20/1985.

**Legal Description**

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Nitrophila mohavensis (Amargosa niterwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (50 FR 20777-20794).

**Critical Habitat Designation**

The critical habitat designation for Nitrophila mohavensis includes one CHU in Inyo County, California (50 FR 20777-20794).

California, Inyo County, Ash Meadows: W ½ sec. 5. E ½ sec. 6, NE ¼ and E ½NW ¼ sec. 7, NW ¼ sec. 8, T25N, R6E.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Nitrophila mohavensis critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include salt-encrusted alkaline flats.

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowering occurs in the late spring (USFWS, 1990).

**Reproduction Narrative**

Adult: Flowering occurs in the late spring; flowers are small, apetalous, and axial (Munz and Roos 1955, Reveal 1978c) (USFWS, 1990).

**Habitat Type**

Adult: Alkaline flats (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits playas (clay, mesic) (Skinner, 1997). Alkaline flats associated with Distichlis spicata var. stricta, Cordylanthus tecopensis, and Cleomella brevipes (Reveal, 1989). (NatureServe, 2015). High ecological integrity of the population and site fidelity and low tolerance ranges are inferred based on the restricted geography this specie inhabits along with the specific habitat requirements of this species.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2007)

**Number of Populations:**

4 Population Services (USFWS, 2020)

**Population Size:**

~235,628 (USFWS, 2020)

**Population Narrative:**

Wetland habitat (Bittman 1998). Populations described as containing thousands of plants (Bittman 1998). Known from two occurrences in California (Bittman 1998), and three in Nevada. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and restricted geographic range.

***Threats and Stressors***

**Stressor:** Threats from Groundwater Development (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Given our current understanding of Amargosa niterwort demographic and hydrologic trends at the Lower Carson Slough population, coupled with the rate of groundwater extraction in the Amargosa Valley, the relative magnitude and imminence of groundwater development are considered high (USFWS, 2007).

**Stressor:** Threats of Habitat Loss or Degradation from Surface Mining (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Given the importance of the Lower Carson Slough and Crystal Reservoir populations and the threat posed by mineral claims on roughly 25 percent of the critical habitat , we conclude the magnitude of this threat is high. Currently, the economic viability of mineral extraction is unknown; therefore, we consider the imminence of this threat to be unknown (USFWS, 2007).

**Stressor:** Threat of Habitat Degradation from Ash Meadows Road (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of listing, Ash Meadow Road did not pose a threat to the Amargosa niterwort. In late 1999 and early 2000, the California Department of Transportation (Caltrans) improved Ash Meadows Road where it crosses the Lower Carson Slough and Amargosa niterwort habitat. Caltrans imported fill and raised the roadbed where it crosses the Lower Carson Slough and in doing so, impacted individual Amargosa niterwort plants. The raised roadbed now poses an indirect threat to the Amargosa niterwort population by altering sedimentation patterns in the Carson Slough during thunderstorms or rare high flow events. Several low-water crossings with drainage pipes are present under the highway; however, during unusually high-volume flows the pipes may be filled with sediment, causing the roadbed itself to act as a dam that retains sediment that could bury a portion of the Lower Carson Slough population (Service 1999). Given the importance of the Lower Carson Slough population, the magnitude of this threat is high. However, given the relative infrequency of flash floods, the overall magnitude and imminence of this threat is low (USFWS, 2007).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The 1985 final rule recognized establishment of the Refuge did not provide any protection for the Amargosa niterwort (50 FR 20777-20794) because the only known population for the Amargosa niterwort was located in California. Presently, with the discovery of the Crystal Reservoir population, a small portion, roughly 5 percent, is now protected on the Refuge and within the adjacent BLM Area of Critical Environmental Concern. Protection under the Act continues to be the most important regulatory mechanism for protecting the Amargosa niterwort because it is the only regulatory mechanism that spans both California and Nevada

state jurisdictions and it is the only mechanism that is able to protect Amargosa niterwort habitat from mining and groundwater pumping in certain situations. For this reason we conclude the magnitude of the threat posed by inadequate regulatory mechanisms is high. We consider this threat to be imminent because groundwater pumping is now at 200 percent above sustainable levels (USFWS, 2007).

**Stressor:** Trampling by wild horses and OHV activity (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Amargosa niterwort populations on the Refuge are relatively well protected; however, the Crystal Reservoir population was impacted by illegal OHV activity in the early 2000s. The effects of OHV activity on this population were scattered over a 0.5 acre area, but were less than 0.01 acre in total. The Tecopa population appears to be at the highest risk to damage from OHV activity. The area is unfenced and tire tracks have been observed going through the small Amargosa niterwort population (Edwards 2006). Given the fencing that has been installed to protect the lower Carson Slough population and the Refuge, which together compose roughly 98 percent of the known distribution, we consider the magnitude and threat posed by trampling by wild horses and OHV activity to be low and non-imminent (USFWS, 2007).

**Stressor:** Invasive Species and Fire (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of indivduals
**Narrative:** Invasive species were described as a threat in the rule to list the species in 1985. Amargosa niterwort habitat consists of barren, salt-encrusted mudflats with little to no vegetation. With the exception of salt cedar (Tamarix sp.), most invasive species present at Ash Meadows lack the special adaptations needed to survive in Amargosa niterwort habitat. Salt cedar is known to be a significant threat to wetlands in the vicinity (Service 2006a). However, salt cedar does not currently appear to be establishing in Amargosa niterwort habitat in either the Lower Carson Slough or below Crystal Reservoir (Servic2006a). Neither the Refuge nor BLM has an active program to remove salt cedar in or near occupied habitat. Fire has recently been identified as a threat to other Ash Meadows endemic plant species due to the increase in non-native species that would carry a fire (e.g., Ash meadows gumplant 5-year review, Service 2007); however, given the sparse cover and open structure of Amargosa niterwort habitat, fire is not expected to pose a significant threat. Given the available information, we conclude the threats posed by non-native species and fire are low and non-imminent (USFWS, 2007).

**Stressor:** Failure of Crystal Spring Dam (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals/Loss of habitat
**Narrative:** A breach of the reservoir would affect the area immediately below the dam, Lower Crystal Marsh, as well as the Lower Carson Slough at Ash Meadows Road (Service 2005). Given the severity of a potential impact, the magnitude of this threat is considered high. However, given the infrequent nature of catastrophic flash flooding and earthquakes in the vicinity that could cause the failure of Crystal Spring Dam, and the absence of human habitation or structures, we consider the imminence of this threat to be low. Nonetheless, Amargosa niterwort habitat

occurs in low-lying areas susceptible to flooding. The Amargosa niterwort population in the Lower Carson Slough has likely survived previous flash floods. However, because the Lower Carson Slough population is now smaller than it was in the 1950s and 1960s, when it was described as extensive, it is less protected against stochastic events such as flash flooding. Further compounding potential impacts from a flash flood event are the hydrologic modifications at Ash Meadows Road (see discussion under Factor A). Given the severity of a potential impact, the magnitude of this threat is considered high. However, given the infrequent nature of catastrophic flash flooding in the vicinity, the imminence of this threat is low (USFWS, 2007).

***Recovery***

**Reclassification Criteria:**
All non-native animals and plant species must be eradicated from essential habitat (USFWS, 2007).

Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 2007).

Essential habitat must be secure from detrimental human disturbance including mining, off-road vehicles, and introduction of non-native species (USFWS, 2007).

Amargosa niterwort is present in all localities that it has occupied historically as identified in Appendix A, Table XV, of the Recovery Plan (USFWS, 2007).

Recovery Priority Number: 8

**Delisting Criteria:**
Criteria shown above for downlisting from endangered to threatened (USFWS, 2007).

Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 2007).

Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 2007).

All of the listed plant species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, of the Recovery Plan, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Recovery Plan Task number 644 needed as an indicator of a selfsustaining plant species. Task number 644 requires that for each listed plant species, frequency data must be gathered from examples of vegetation that is unaltered, to quantify recovery objectives. Sampling method must be determined, including the size/shape of sampling units and the number of units needed to accurately estimate frequency values (USFWS, 2007).

**Recovery Actions:**

- Downlisting criterion #1, the removal of all non-native animals and plant species from essential habitat, has been partially achieved (Factor E). While non native species are not currently a direct threat to the Amargosa niterwort, salt cedar (Tamarix ramosissima) is generally a problem in the Carson Slough and wetlands on the Refuge. The Refuge has recently prepared an Integrated Pest Management Plan (Service 2006a). This plan provides a framework for managing invasive species, including salt cedar. In addition, the Refuge recently secured funding for salt cedar removal activities. These activities have only recently been implemented and have not yet produced on-the-ground results. The Bureau of Land Management (BLM) Las Vegas District has recently completed an Interagency Agreement with the Lake Mead National Recreation Area Exotic Plant Management Team for spot removal of non-native species within the Upper Carson Slough watershed. This work is ongoing (USFWS, 2007). Delisting is contingent on completion of the downlisting criteria described above. Delisting criterion #1, successful completion of the downlisting criteria, has not been completed. Criteria #2, 3 and 6 which address establishing corridors and re-establishing historical plant community structure are beginning to be addressed but have not been completed. The Refuge recently completed a Geomorphic and Biological Assessment for the Refuge (Service 2006b) which describes targets states for hydrologic and biologic functioning. The Refuge also recently completed an Integrated Pest Management Plan which outlines a strategy for managing weeds on the Refuge (Service 2006a). These efforts are just beginning and no tangible on-the-ground results have been achieved (USFWS, 2007).

- Downlisting criterion #2, secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer, has only partially been achieved (Factor A). See discussion in section II.C.2.a. Protecting a minimum water level in Devils Hole will protect Amargosa niterwort occurrences on the Refuge; however, it may not protect critical habitat and the Lower Carson Slough occurrence which depend in part on subsurface flows from the Amargosa Valley (USFWS, 2007).
- Downlisting criterion #4, securing essential habitat from detrimental human disturbance including mining, off-road vehicles, and introduction of non-native species, has been partially achieved (Factor A). See discussion under section II.C.2.a. Occurrences on the Refuge receive protection from off-road vehicles and surface mining on lands where the Service owns mineral rights. The Lower Carson Slough population receives limited protection from fencing installed on both sides of Ash Meadows Road. Active mining claims are present adjacent to the Lower Carson Slough population; this population could be indirectly affected by dewatering or other mining activities. Public minerals are available and minerals claims can be made on the Crystal Reservoir population; the economic incentive for these claims is unknown (USFWS, 2007).
- Downlisting criterion #6 has not been completed. Amargosa niterwort is not present in all localities that it has occupied historically as identified in Appendix A, Table XV (USFWS, 2007).
- For the Amargosa niterwort, implementing population monitoring and investigating the factors that affect recovery are crucial (as described in tasks 4 and 6 in the Recovery Plan). Determining population trends for this species as described in the Recovery Plan is imperative and should be the first priority and should be performed over the next five years. Groundwater pumping will likely continue to increase in the Amargosa Valley. Documenting population trends will be paramount to identify any changes associated with such pumping. Before monitoring surveys are implemented, a long-term population monitoring plan for the Amargosa niterwort should be prepared to ensure that the necessary statistical rigor is included. Permanent plot markers were placed as part of the mapping and sampling plots

set up during a demographic study by San Diego State University (SERG 2004). These plots offer a unique opportunity to gather quantitative population trend data for the species. This study should be incorporated into the longterm population monitoring plan (USFWS, 2007).

- Additional research into the hydrology of the Central and Lower Carson Slough as it relates to the Ash Meadows and Alkali Flat/Furnace Creek hydrologic subbasins is needed. This should be the second priority for this species. Additional groundwater monitoring wells should be installed in the Central and Lower Carson Slough as part of the research (USFWS, 2007).
- Limiting potential flash flood or failure of Crystal Spring Dam impacts to the Lower Carson Slough population is critical. To accomplish this, modifications to Ash Meadows Road should be pursued to restore the natural hydrology that supports the Amargosa niterwort. Additionally, the repair, modification or removal of Crystal Spring Dam should be studied and implemented. These actions should be the third priority for this species (USFWS, 2007).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); and III. Support Amargosa niterwort research across its range to monitor populations as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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# SPECIES ACCOUNT: *Oenothera deltoides ssp. howellii* (Antioch Dunes evening-primrose)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A biennial herb that forms tufts of coarse, heavily-branched, drooping stems. Lower leaves grayish, pubescent, form basal rosette. Flowers bell-shaped, acquiring a blush of pink with age (Smithsonian Institution 1980). (NatureServe, 2015)

**Taxonomy**

Oenothera deltoides subsp. howellii is a short-lived perennial in the primrose family (Onagraceae) (USFWS, 2019).

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to the Antioch Dunes, known from Contra Costa County and introduced in Sacramento County, California (Skinner 1997). (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 8/31/1978.

**Legal Description**

On August 31, 1978, the U.S. Fish and Wildlife Service, designated critical habitat for Oenothera deltoides ssp. howellii (Antioch Dunes evening-primrose) under the authority of the Endangered Species Act of 1973 (43 FR 39042 - 39044). Critical habitat was designated for one unit in California.

**Critical Habitat Designation**

One critical habitat unit is designated in California, described as: An area of land, water, and airspace in Contra Costa County with the following components: T. 2 N. R. 2 E. SW 1/4 section 17, E 2/3 of S 1/3 of section 18 (43 FR 39042 - 39044).

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements are not described (43 FR 39042 - 39044).

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Self-incompatible, requiring cross-pollination for viable seed, insect pollinated (USFWS, 1984; 2019)

**Reproduction Narrative**

Adult: The Antioch Dunes evening-primrose is vespertine; the flowers open in early evening and close by mid-morning. In the garden, the plant flowers from “March to May and briefly in September’ (Roof 1969). This Oenothera is self-incompatible (Klein 1970) and thus requires cross-pollination for sound seed. Arnold (pers. Comm. 1982) believes that bees are the primary pollinating agent at Antioch. Although hawkmoths were not known on the dunes until 1983, they have been reported as pollinators of other Oenothera species (Gregory 1963). Their role as pollinators of Antioch Dunes evening-primrose has not been documented. Studies are needed to determine the phenology, pollinators and seed dispersal mechanisms of this subspecies (USFWS, 1984).

**Habitat Type**

Adult: Interior dunes on the "Antioch Dunes" along the shore of the San Joaquin River in Contra Costa County, California , occurring in nearly pure and shifting sand (USFWS, 2019).

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits inland dunes; this species will not mature where adult plants have previously grown unless fresh sand is deposited (Smithsonian Institution 1980 and Skinner 1997 in NatureServe, 2015). O.d. subsp. howellii is considered almost entirely restricted to the reamaining Anitoch Dunes habitat at the Anitoch Dunes Natural Wildlife Refuge, which encompasses 67 acres (the 41-acre Stamm Unit, owned by the Service and the 26-acre Sardis Unit, of which 14 acres are owned by the Service and 12 acres are owned by Pacific Gas and Electric)(USFWS, 2019).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2019)

**Number of Populations:**

4 (Stamm Unit, Sardis Unit, transplanted location on Browns Island, and Brannan Island)(USFWS, 2019).

**Population Size:**

2,368 (as of 2017)(USFWS, 2019)

**Population Narrative:**

According to the CNDDB (2018a), Oenothera deltoides subsp. howellii is known from 10 EOs, nine of which are presumed extant and one of which is considered likely extirpated (Table 2). Of the nine presumed extant EOs, six are considered natural occurrences and three are considered transplanted outside of native habitat and/or range. The total population in 2017 was estimated at 2,368 individuals, with 2,334 plants counted at the ADNWR (2,008 at the Stamm Unit and 326 at the Sardis Unit) and 34 plants at one of the transplanted locations at Browns Island (Table 2). Population numbers have shown some improvement since the 2008 Five-Year Review, as illustrated by plant count numbers from ADNWR (Figure 5; Service 2018a, Service No Date). However, despite the improvement, the overall population is still not considered stable or self-sustaining due to the overall low population numbers, low redundancy of populations, and continuing and increasing threats (USFWS, 2019).

***Threats and Stressors***

**Stressor:** Habitat destruction from sand mining, industrial and urban/suburban development, and/or conversion to agriculture
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat for the Lange's metalmark, O.d. subsp. howellii, E.c. var. angustatum, and pollinators, and area available for habitat restoration is threatened by destruction and conversion to other uses. This threat is largely ameliorated on the ADNWR and other properties with protection/management agreements in place, but not on properties without such agreements (USFWS, 2019).

**Stressor:** Habitat degradation due to loss of natural disturbance regime
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** The reduction in sand deposition in Antioch Dunes habitat as a result of water management/use (dams, levees, etc.) in the Sacramento/San Joaquin River Delta system and reduced effectiveness of wind-driven dispersal of sand and disturbance of dunes has and continues to reduce overall size and connectedness of the dune natural community (USFWS, 2019).

**Stressor:** Habitat degradation due to non-native and native invasive vegetation
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Invasive vegetation colonizes open sand habitat, reducing available suitable Lange's metalmark, O.d. subsp. howellii, E.c. var. angustatum, and pollinator, habitat. Invasive plants out-compete native species, including Lange's metalmark host and food plants, and O.d. subsp. howellii and E.c. var. angustatum, for sunlight, space, nutrients, and moisture. They also stabilize the sand/soil, eliminating the natural disturbance regime and may cause soils to become more eutrophic (Thomson 2005a, Thomson 2005b, Chin 2012, McNally 2014). The 2008 Five-Year Review notes that the proliferation of non-native invasive plants has been increasing rapidly since 1998 (Service 2008) and these conditions continue (Chin 2012, McNally 2014, Service 2018a, Service 2018b, Service 2018c, Service 2018d). The use of herbicides to control non-native and native invasive vegetation may also present potential threat to Lange's metalmark host and food plants, O.d. subsp. howellii, and E.c. var. angustatum occurring in the same vicinity. Applying

herbicides selected for the target species and using appropriate rates and technique should minimize effects to non-target Lange's metalmark host and food plants, O.d. subsp. howellii, and E.c. var. angustatum. These practices have been instituted at the ADNWR, so this threat is considered largely ameliorated there (Service 2008), but it may pose a risk to current and future occurrences of these listed species elsewhere. Additionally, some herbicides may pose threat directly to Lange's metalmark. In a study of Behr's metalmark, a close relative of Lange's metalmark butterfly, the herbicides triclopyr, sethoxydim, and imazapyr were found to reduce the number of adults that emerged from pupation by 24-36% after exposure to typical field application rates (Stark et al 2012 in Richmond et al 2015) (USFWS, 2019).

**Stressor:** Habitat degradation due to gypsum dust deposition from neighboring plant (facility)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 2008 Five-Year Review reported that gypsum dust building up on plants may reduce exposure to sunlight and decrease photosynthesis. It may also alter soil chemistry due to introduction of calcium and sulphates, which may affect the growth of Lange's metalmark host and food plants, O.d. subsp. howellii and E.c. var. angustatum and promote colonization by invasive species. Deposition is noted as affecting mostly the Sardis Unit. The ADNWR staff have met with Georgia-Pacific (G-P) about concerns over the dust and G-P increased efforts to reduce airborne gypsum (beyond the standards for air pollution control) by keeping it wetted down when possible during production activities. At the time of the 2008 Five-Year Review, staff noted a reduction in dust from G-P efforts. The review noted that there was no evidence that gypsum dust was adversely affecting any of the three species (Service 2008). However, it also cited a study that demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1945 in Service 2008), which may affect Lange's metalmark and pollinators of O.d. subsp. howellii or E.c. var. angustatum. The ADNWR staff reported an increase in gypsum dust deposition at ADNWR in 2017-2018 (Susan Euing pers. comm. December 12, 2018). In 2018, staff noted that gypsum was being deposited on the refuge at concentrations that coats plants, leading to cancellation of surveys for the Lange's metalmark in some parts of the refuge (Susan Euing pers. comm. August 17, 2018). In 2019, after several weeks into the Lange's metalmark survey season, ADNWR staff confirmed that no surveys had been canceled due to concerns about gypsum dust deposition (Louis Terrazas pers. comm. September 10, 2019). The magnitude of this potential stressor requires further investigation and Service partnership with G-P is ongoing (USFWS, 2019).

**Stressor:** Habitat degradation due to rogue hiking/trails
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This activity may cause direct injury or mortality to the Lange's metalmark, to its host and food plants, and to O.d. subsp. howellii and E.c. var. angustatum from trampling while also increasing potential for accidental introduction of wildfire from hikers. These threats and stressors were significantly reduced when ADNWR was fenced in 1986 and the 2008 Five-Year Review (Service 2008) no longer considered recreational and pedestrian traffic to be a significant threat. However, ADNWR staff note that incidence of trespassing and human encampments at ADNWR has increased in the past several years (Susan Euing pers. comm. December 12, 2018) (USFWS, 2019).

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes
**Exposure:**
**Response:**
**Consequence:** Extirpation
**Narrative:** These activities represent a threat to the Antioch Dunes species from direct mortality of any individual(s) collected and a reduction in annual recruitment by killing or injuring reproductive individuals (USFWS, 2019).

**Stressor:** Disease or predation
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Evidence exists of O.d. subsp. howellii infestation by beetles (possibly family Chrysomelidae), which feed on petals, pollen, and seed pods. Also, in the early 1980s up to 50% of O.d. subsp. howellii was infested with small mirid bugs (family Miridae of the insect order Hemiptera) that prey upon O.d. subsp. howellii, and these insect predators remained an identified threat in 2008 (Service 2008). The magnitude of this stressor requires further investigation (USFWS, 2019).

**Stressor:** Wildfire
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Wildfire may cause direct mortality of O.d. subsp. howellii and E.c. var. angustatum plants during vulnerable life stages. These stages include the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. However, historical evidence indicates that the native plants may recover rather quickly from a wildfire (Service 2008). Any mortality would also result in reduced annual recruitment by killing or injuring reproductive individuals. The threat extends to pollinators and other pollinator plant species (USFWS, 2019).

**Stressor:** Fuelbreak discing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fuelbreak discing may cause direct injury or mortality to Lange's metalmark, its host and food plants, and to O.d. subsp. howellii, and E.c. var. angustatum. However, it also creates open, disturbed, sand/soil that may be suitable for colonization by O.d. subsp. howellii and E.c. var. angustatum, as well as invasive vegetation. The net impact of this activity to listed plant resilience is unquantified (USFWS, 2019).

**Stressor:** Loss of pollinators
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Lange's metalmark is addressed as a pollinator for this discussion of the potential threat posed by possible insecticide drift from mosquito abatement spraying on neighboring

properties (Richmond et al 2015). The Mosquito Abatement District allows for spraying of insecticides to reduce the incidence of West Nile Virus at a wetland adjacent to the Stamm Unit of the ADNWR. The spray could drift on to the refuge and affect pollinators, such as Lange's metalmark and those that pollinate O.d. subsp. howellii or E.c. var. angustatum. While ADNWR staff have worked with county mosquito control staff to minimize effects from this potential threat, the magnitude of this stressor requires further investigation. As of the 2008 Five-Year Review, there was no evidence that lack or loss of pollinators has negatively impacted O.d. subsp. howellii or E.c. var. angustatum (Service 2008), but both species require cross-pollination, so an adequate pollinator population is necessary. Bees are suspected pollinators for both species and hawkmoths may also be pollinators for the primrose; however, actual pollinator taxa are unknown. This potential threat requires investigation (USFWS, 2019).

**Stressor:** Low population numbers
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oenothera deltoides subsp. howellii and E.c. var. angustatum are threatened by few and small populations that are limited to a small and localized distribution, which increases the risk of extirpation and extinction due to: (1) Reduced resiliency (the ability of a species to withstand stochastic disturbance; resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations); (2) Low redundancy (spreading risk among multiple populations or a large area to minimize the potential loss of the species from catastrophic events); and (3) Low representation (the breadth of genetic and environmental diversity within and among populations that influences the ability of a species to adapt to changing environmental conditions over time) (USFWS, 2019).

**Stressor:** Climate change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oenothera deltoides subsp. howellii and E.c. var. angustatum are threatened by multiple environmental effects anticipated with climate change, which may result in loss of habitat, altered temperature and moisture regimes causing direct mortality and/or impaired reproduction, and altered temperature and moisture regimes causing indirect mortality and/or impaired reproduction via phenological mismatches with pollinators and between pollinators and their host and/or other nectar plants (Richmond et al 2015) (USFWS, 2019).

***Recovery***

**Reclassification Criteria:**
There are at least five separate self-sustaining (all plants are naturally recruiting*) populations, including: at least three populations, each with a 15-year moving median of at least 4,800 flowering plants; and at least two populations, each with a 15-year moving median of at least 1,500 flowering plants (USFWS, 2019).

A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations (USFWS, 2019).

Populations should be protected and have in place a long-term management plan for the conservation of O.d. subsp. howellii and commitment for implementation of the plan (USFWS, 2019).

**Delisting Criteria:**
There are at least seven separate self-sustaining (all plants are naturally recruiting (*Any flowering individuals counted as naturally recruiting would have to be ≥ two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ.)) populations including: at least five populations, each with a 15-year moving median of at least 4,800 flowering plants; and at least two populations, each with a 15-year moving median of at least 1,500 flowering plants. OR, population viability analysis determines that O.d. subsp. howellii has a range-wide 95% probability of persistence over a 100-year period. a. A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. b. Populations should be protected and have in place a long-term management plan for the conservation of the O.d. subsp. howellii and commitment for implementation of the plan. (USFWS, 2019)

A post-delisting monitoring plan for the species has been developed (USFWS, 2019).

**Recovery Actions:**

- The final supporting actions for Primary Action 1 include identification of other essential habitat and developing an MOU with the landowner to develop protective alternatives and actions. Since listing, the only new habitat identified for conservation is the property owned by the Pioneer Companies, Inc., and currently occupied by the McCullogh-Kemwater North American Company. All three of the Antioch Dunes species have been surveyed on this property (USFWS 2005). Currently, this property is for sale and the Service is considering alternatives that include purchasing this valuable habitat (USFWS, 2008).
- The initial supporting actions for Primary Action 2 are essentially the same for all three endangered Antioch Dunes species, and include conducting annual census of population and habitat; captive breeding (Lange's metalmark butterfly) or propagation and outplanting (Antioch Dunes evening-primrose, Contra Costa wallflower); developing and implementing a habitat restoration plan; and conducting studies of the biology of the species which include life history (Lange's metalmark butterfly), autecological studies (Antioch Dunes evening-primrose, Contra Costa wallflower), habitat requirements (Lange's metalmark butterfly), population biology (Lange's metalmark butterfly), and reproductive studies (Antioch Dunes evening-primrose, Contra Costa wallflower). Out-planting buckwheat host plants is also needed for Lange's metalmark butterfly. All of these actions have been ongoing and are discussed below in section IIC. Another group of supporting actions includes rebuilding the natural dune substrate and topography to the degree feasible by negotiating with the Army Corps of Engineers (Corps) and the Port of Stockton for sandy dredged material, preparing the sites for deposition of dredged material, and surveying the sites for candidate and listed species in order to ameliorate any negative effects. Several sources of sand were used in restoration efforts since listing the three species. Dredged material was found to contain a substantial amount of fine non-silica sediment which proved to stabilize too quickly for use as a substitute for the original dune sand (C. Smith in litt. 2007). Antioch Dunes NWR staff recently located several sources of local high-silica content sand that should prove useful in the restoration; however, although funding sources are being sought for purchasing and delivering the sand, current plans tentatively include testing the composition of the

imported sand prior to using it to supplement the refuge. (C. Smith in litt 2007; L. Terrazas, USFWS, pers. comm. 2008). Other actions include removal of a vineyard and removal of other non-native invasive vegetation throughout the Antioch Dunes NWR. The vineyard was removed in 1983 and removal of non-native invasive vegetation has been an ongoing effort (see section IIC for updated status on the restoration) (USFWS, 2008).

- Supporting actions for this include erecting interpretive signs, printing and distribution of leaflets describing the Antioch Dunes NWR's unique dune ecosystem and the need for restoration, and the development of an environmental education program. These actions were completed in the early 1980s; however, the public awareness effort is a dynamic and ongoing process (USFWS, 2008).
- Continue restoration of riverine dune habitat at Antioch Dunes NWR (USFWS, 2008)
- Conduct controlled propagation of the Lange's metalmark butterfly until natural populations at Antioch Dunes NWR are at a self-sustainable level (USFWS, 2008)
- Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys (USFWS, 2008)
- Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR (USFWS, 2008)
- Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California (USFWS, 2008)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Several areas of future action are suggested over the next five years, which build on the actions articulated in the revised recovery plan (Service 1984) and the riverine dune ecosystem conservation strategies articulated in Service (2019b). These areas include: continuing to restore riverine dune habitat at ADNWR and considering nearby locations for restoration activities; continuing research on the habitat requirements, life history, and seed bank dynamics of Antioch Dunes evening-primrose; improving statistical analysis and numerical modeling related to Antioch Dunes evening-primrose; considering development of a publicly-accessible website for documents, literature, and data related to Antioch Dunes evening-primrose; and establishing an Antioch Dunes Recovery Implementation Team or recovery working group. Continued research on the habitat requirements and seed bank dynamics of Antioch Dunes evening-primrose could include identifying areas for possible development of new populations of Antioch Dunes evening-primrose. For example, the Service's experience with dune restoration at the Refuge in combination with the work of Jones et al. (2019) provides a strong foundation for expanding dune restoration work over the coming years. This future work could include an analysis of how environmental variables, such as precipitation and temperature patterns influence population dynamics in currently occupied areas and colonization of newly restored dunes. It is also not currently clear which invertebrate species are the most important pollinators of Antioch Dunes evening-primrose. A study of the current pollinators of primrose at Antioch Dunes would help add to our understanding of the natural history of this subspecies and identify which potential pollinators to monitor to ensure that healthy pollinator populations continue to occur at and near the Antioch Dunes ecosystem. Statistical and numerical modeling, such as with habitat suitability analysis and population dynamics modeling, can provide insights into possible future locations for development of Antioch Dunes evening-primrose populations, and future dynamics of these populations. Jones et al. (2019) began developing habitat suitability models for primrose using remote sensed vegetation metrics (NDVI; Normalized Difference Vegetation Index). It is possible that a continuation of this line of investigation will lead to improved insights into where and how to develop additional restored sand dunes that will support the recovery of this subspecies. It may also be useful to consider developing population viability analyses (PVA) that are specifically developed for Antioch Dunes evening-primrose. For example, it is possible that the stagestructured matrix population model developed by Thomson (2005a) could be used to form a foundation for PVA analysis. It is also possible that building and parameterizing such a model, and then projecting this model into various possible futures, including under the influence of changing climate conditions, could help provide insights beyond the PVA's suggested by recovery criteria in Service (2019a). As part of efforts to improve statistical analysis and modeling, creating a well-vetted and archived dataset of all Antioch Dunes evening-primrose surveys, and resolving any discrepancies in counts identified during this review will be critical to progressing on this objective. In late 2019, staff of the Bay-Delta Fish and Wildlife Office met with the staff of the ADNWR and considered formally convening a recovery implementation team (RIT) for the listed species that occur at the Refuge, including Antioch Dunes evening-primrose. The primary purpose for convening this group would be to encourage Service biologist and managers and external experts to consider recovery priorities for these species and the Antioch Dunes ecosystem, and continue to stay abreast of emerging research related to primrose, riverine dune ecology, and other relevant topics. This group would also help develop a recovery implementation strategy for Antioch Dunes. (USFWS, 2020)

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# SPECIES ACCOUNT: *Opuntia treleasei* (Bakersfield cactus)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A flat-padded (beavertail) opuntia cactus, with the eye-spots (which are not sunken) having spines as well as bristles. Typically flowers in May. (NatureServe, 2015)

**Taxonomy**

USFWS treats as Opuntia treleasei (8/93). (NatureServe, 2015)

**Historical Range**

Historically, Bakersfield cactus was distributed in the low foothills northeast of Oildale and along the southeastern portion of the San Joaquin Valley floor to the low foothills of the Tehachapi Mountains south of Arvin in Kern County (Service 1990, p. 29363). In the late 1980s, its range was extended to the south when Bakersfield cactus was identified in several locations northwest of the community of Wheeler Ridge (Service 1998, p. 50). At the time of listing in 1990, Bakersfield cactus was documented in five general populations in Kern County: oilfields northeast of Oildale, Kern River Bluffs northeast of Bakersfield, bluffs and rolling hills west and north of Caliente Creek east of Bakersfield, Comanche Point on the Tejon Ranch southeast of Arvin, and northwest of Wheeler Ridge (Service 1990, p. 29364). (USFWS, 2025)

**Current Range**

California: San Joaquin Valley (central Kern County). Other reports are no longer considered to be this taxon (cf. Munz 1974; Benson 1982; Brown and Cypher 1997).

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated/Vegetative reproduction (USFWS, 1998)

**Lifespan**

Adult: at least 48 years (USFWS, 1998)

**Breeding Season**

Adult: Bakersfield cactus typically flowers in May (Munz and Keck 1959) (USFWS, 1998).

**Reproduction Narrative**

Adult: Bakersfield cactus is a perennial. The life span of wild plants has not been determined, but clumps in cultivation at the Rancho Santa Ana Botanic Garden in Claremont, California, survived for 48 years, until extremely wet winter weather caused the pads to rot (R. van de

Hoek pers. comm.). Bakersfield cactus typically flowers in May (Munz and Keck 1959). Reproductive biology of this taxon has not been studied, but certain other Opuntia species require cross-pollination for seed-set and many are pollinated by bees (Benson 1982, Spears 1987, Osborn et al. 1988). One potential pollinator of Bakersfield cactus is the native solitary bee Diadasia australis ssp. caIifornia, which is known to occur in Kern County and which specializes in collecting pollen from Opuntia species (Thorp in litt. 1998). Vegetative reproduction, which is the production of new plants from sources other than seed, is typical in Bakersfield cactus and several related species (Benson 1982). Fallen pads root easily if sufficient water is available (Twisselmann 1967, Benson 1982, Mitchell 1988), but Bakersfield cactus does not survive prolonged inundation (ESA Planning and Environmental Services 1986a). Bakersfield cactus produces seeds infrequently. Van de Hoek (pers. comm.) noted that the frequency of seed set in extant populations is similar to the proportion of seeds he observed in herbarium specimens. Cactus seeds require warm, wet conditions to germinate, a combination which is extremely rare in the Bakersfield area (Benson 1982). Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986a), but seed dispersal agents are unknown (USFWS, 1998).

**Habitat Type**

Adult: Grasslands (USFWS, 1998)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits sandy soils or sand flats and low hills mostly in grassland at 120-550 m (Benson 1982; Brown and Cypher 1997). Characteristic in Sierra-Tehachapi Saltbush Scrub community, but also in Blue Oak Woodland and a riparian woodland.  (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on its specific habitat needs and low number of known populations.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986), but seed dispersal agents are unknown (USFWS, 2011).

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

51 extant (USFWS, 2025)

**Population Narrative:**

Overall, the current distribution of Bakersfield cactus is similar to as described in the 2020 status review, and no status changes have occurred in the Diversity Database. There are 62 total occurrences composed of nine extirpated, two possibly extirpated, and 51 presumed extant occurrences (Diversity Database 2025b, entire). Of the presumed extant occurrences, six are transplants outside of the species' native habitat or range (Diversity Database 2025b, pp. 63–68; see Conservation). (USFWS, 2025)

***Threats and Stressors***

**Stressor:** Agricultural Conversion and Urbanization (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The primary threats to Bakersfield cactus over its entire habitat range continue to be residential development and conversion to agriculture. Continuing threats to localized populations that were identified in the listing rule include urbanization events such as; road expansion and maintenance (Oildale Area (within the MBNKR Recovery Site), Wheeler Ridge, and Sand Ridge), expansion of the Kern River Power Plant (Kern Canyon), the county airport (MBNKR), and the Bena landfill (Caliente-Bena Hills); as well as oil and gas development (Oildale Area (within the MBNKR) and Wheeler Ridge), Off road vehicle use (MBNKR and Cottonwood Creek), sand and gravel mining (Sand Ridge) and California Aqueduct right-of-way maintenance (Wheeler Ridge) (Cypher pers comm. 2010). All of these activities continue to threaten Bakersfield cactus by the modification of its habitat, the removal of Bakersfield cactus clumps, and the further fragmentation of existing populations. Table 2 summarizes land ownership and protected status (USFWS, 2011).

**Stressor:** Oil and Gas Extraction and Conveyance (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Oil and gas extraction and conveyance continue to threaten Bakersfield cactus. Adverse effects of oil and gas development on Bakersfield cactus include the loss of habitat, change in habitat quality, destruction of individuals or populations and their seedbank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. According to our HCP database (Service 2010), there is one HCP that covers oil and gas production that includes Bakersfield cactus as a covered species. The Nuevo Energy Company and Torch Operating Company (Nuevo/Torch) HCP was permitted in 1999 for a 30-year permit term. The project size is 21,800 acres with 1,700 acres impacted. The mitigation includes 800 acres to be created, enhanced, or restored, and 840 acres to be protected. Approximately 1,328 acres of the total 21,900 acres in the Nuevo/Torch Plan Area may be suitable for Bakersfield cactus (Nuevo/Torch 1999). Only those Nuevo/Torch lands east of Highway 99 overlap with reported occurrences of Bakersfield cactus. Bakersfield cactus has a limited range and is only found in western Kern County. Therefore Nuevo/Torch proposed avoidance and minimization measures are particularly important for this species. Oil and gas development is often limited and linear in nature in terms of well pads and pipeline construction but where oil and gas fields are developed into production sites, the cumulative impact can be large. Three of the five largest U.S.

oil fields are in Kern County and span more than one million acres (USFWS, 2011).

**Stressor:** Conservation Efforts (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Approximately 1068.40 acres (74.6 percent) of occupied presumed extant Bakersfield cactus habitat is on private land that is not protected from agricultural conversion, urbanization, oil and gas development, and off road vehicle use. About 144.35 acres (10.1 percent) of occupied presumed extant Bakersfield habitat is on private land that is protected. About 115.03 acres (8 percent) of presumed extant Bakersfield cactus habitat is on public land that is not protected from oil and gas development, off road vehicle use, and utility operation and maintenance; 104.37 acres (7.3 percent) is on protected public lands (USFWS, 2011).

**Stressor:** Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** At the time of listing we stated that many cacti are collected and cultivated by plant collectors, or offered for sale or trade by cactus growers. Although there have been no reports of such trade in Bakersfield cactus, the species may still be collected and cultivated (Service 1990). Currently, we have no evidence whether this has occurred. Currently, the lack of monitoring means that we probably would not detect collection or vandalism, especially on private land (USFWS, 2011).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** In summary, the Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1990. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2011).

**Stressor:** Nonnative annual grasses and increased fire frequency (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Nonnative annual grasses directly threaten the survival of mature cactus plants and hinder the establishment of new plants (ESA Planning and Environmental Services 1986; Mitchell 1988). In 2002-2004, mortality of Bakersfield cactus clumps and low rates of vegetative and sexual reproduction at Sand Ridge Preserve were attributed to competition with nonnative annual grasses for water during years with below-average precipitation (Cypher and Fiehler 2006; Cypher pers. comm. 2006). Nonnative annual grasses also indirectly affect Bakersfield cactus in three ways. First, indirect effects from nonnative annual grasses include increased fire frequency

(Service 1998; Brooks 1999; Brooks and Pyke 2001; Brooks 2003), damage from insects (Burger and Louda 1994), and rot of cactus pads during wet years (Service 1998). Fire suppression has allowed the extensive growth of nonnative grasses in some areas to the detriment of Bakersfield cactus (Moe 1989). Also, nonnative annual grasses, which are adapted to fire, increase the fuel load in fire-intolerant saltbush (Atriplex sp.) habitat, where Bakersfield cactus is found, resulting in an increase in fire frequency (Brooks 1999; Brooks and Pyke 2001; Brooks 2003). Although the effect of repeated fires on Bakersfield cactus has not been determined, the survival of Bakersfield cactus plants was monitored following single fire events at Sand Ridge (R. Hewett, Sand Ridge Preserve Manager, in litt. 1987) and near the Rio Bravo Hydroelectric Power Plant in Kern Canyon (Lawrence 1987; George Lawrence and Associates 1988). All of the Bakersfield cactus clumps survived the fires at both sites, despite wilting and browning of the pads. During the following spring, Bakersfield cactus plants that were subjected to low-intensity flames flowered; however, those subjected to moderate-intensity flames produced only vegetative growth. Second, dense grass also may harbor insects that damage cactus, as was observed with related species of Opuntia in Nebraska grasslands (Burger and Louda 1994), but not yet studied in Bakersfield cactus. Third, the dense grass cover creates a moist microclimate which may promote the growth of decay organisms and cause cactus pads to rot more in years of above-average precipitation (Service 1998) (USFWS, 2011).

**Stressor:** Loss of genetic diversity (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Extirpation
**Narrative:** The destruction of Bakersfield cactus habitat by agriculture and urban sprawl has left the remaining populations highly fragmented and small. The small size of many of the populations (Moe 1989; CNDDB 2010), presumed lack of gene flow between populations, and infrequent sexual reproduction (Menges 1986) may result in a lack of genetic diversity (Service 1998) although this has not been tested in Bakersfield cactus. Populations that are low in genetic variation are more vulnerable to diseases and parasites (Burdon and Marshall 1981) and to chance events, including environmental fluctuations, catastrophes, and genetic drift (Menges 1991). Several of the occurrences have few individuals (CNDDB 2010) and could be subject to loss of genetic diversity (USFWS, 2011).

**Stressor:** Flooding (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Bakersfield cactus populations located in floodplains are threatened by flooding. Bakersfield cactus plants cannot survive long periods of inundation (ESA Planning and Environmental Services 1986; Service 1998). Populations within the Caliente Creek floodplain have been extirpated due to flooding, and flooding continues to be a threat for the Caliente - Bena Hills populations (Service 1998; CNDDB 2010). Populations of Bakersfield cactus within the California Aqueduct right-of-way are also potentially threatened by flooding. Kern County identified earthquakes as highly significant hazard to all regions of Kern County. Large earthquakes can cause secondary hazards including landslides, fire, and flooding. The California Aqueduct crosses the White Wolf Fault at Wheeler Ridge and parallels the San Andreas Fault within 25 miles for most of its length in Kern County (Kern County Fire Department Office of Emergency Services 2005). The largest concentration of clumps in the Wheeler Ridge population

is located adjacent to an overflow drain for the Aqueduct, which could lead to flooding if an earthquake occurred anywhere along its length (Service 1998) (USFWS, 2011).

**Stressor:** Air pollution (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Reduced reproduction
**Narrative:** The Recovery Plan cites Messick (1987) as stating that air pollution is suspected to have contributed to the decline of Bakersfield cactus. Messick noted that populations of Bakersfield cactus appeared to be reproducing less and losing vigor and that soft tissues may be adversely affected by acid deposition or ozone. He suggested that study of possible air pollution effects was needed (USFWS, 2011).

**Stressor:** Reproductive threats (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Reduced reproductive success
**Narrative:** Reproduction of Bakersfield cactus may be threatened by the loss of pollinators. The reproductive biology of Bakersfield cactus has not been studied, but other Opuntia species are known to require cross-pollination for seed-set and many are pollinated by bees (Benson 1982; Spears 1987; Osborn et al. 1988; Thorp in litt. 1998). Pollinators are threatened by the use of both regulated (e.g., malathion) and unregulated pesticides (e.g., pyrethroids) (Service 2000; DPR 2006; Keith 2006). Malathion, a broad spectrum insecticide, has been used to control the beet leaf-hopper (Circulifer tenellus) in rangeland habitat, fallow fields, oil fields, and cultivated areas on both public (BLM) and private lands in the San Joaquin Valley, and in adjacent valleys and foothills. Increasingly, malathion is used to kill agricultural pests and mosquitoes, which are documented as vectors of the West Nile Virus. Its application therefore, is not limited to agricultural areas but includes residential and commercial zones thereby increasing the regional areas in which it is used. Hymenopterans (ants, wasps, bees, etc.) are particularly susceptible to malathion exposure (Dobroski and Lambert 1984) (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Climate models predict for California an overall warming of 1.7 degrees to 5.8 degrees Celsius (3.0 degrees Fahrenheit to 10.4 degrees Fahrenheit) by 2100 (Cayan et al. 2006), but they vary in their predictions for precipitation. VanRheenen et al. (2004) predict a decrease in precipitation in the southern San Joaquin Valley. Bakersfield cactus seeds require warm, wet conditions to germinate (Benson 1982). Therefore, a sufficient decrease in precipitation could hinder Bakersfield cactus growth by sexual reproduction. Additionally, studies at Sand Ridge Preserve revealed increases in Bakersfield cactus mortality and lowered rates of vegetative and sexual reproduction in years of below-average precipitation due to competition for water with nonnative annual grasses (Cypher and Fiehler 2006; Cypher pers. comm. 2006). Conversely, increases in annual precipitation would possibly promote the growth of decay organisms resulting in the rot of cactus pads (Service 1998). Bakersfield cactus cannot tolerate prolonged periods of inundation as observed in the Caliente Creek floodplain (ESA Planning and Environmental Services 1986; Service 1998; CNDDB 2010). The effect of such changes in climate

on nonnative species and parasites is unknown, but could accelerate their establishment in Bakersfield cactus habitat. If such changes in climate occur, and the resulting changes in precipitation occur, Bakersfield cactus could be extirpated with no available refugia (USFWS, 2011).

**Stressor:** Pesticides (USFWS, 2025)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As discussed in our previous review, Bakersfield cactus may require pollinators to produce seeds (Service 2011, p. 14). The taxon's reproductive biology has not been thoroughly studied, and the primary reproductive mechanism appears to be vegetative, but several other Opuntia species require cross-pollination, including by bees, to set seeds (Cypher et al. 2015, p. 5; Grant and Grant 1979, pp. 322–324; Osborn, Kevan, and Lane 1986, pp. 90–92). Potential pollinators of Bakersfield cactus are Diadasia rinconis, a native miner bee that has been observed visiting Bakersfield cactus flowers, and potentially Diadasia australis ssp. californica (a miner bee) and Anthophora fulvicauda (a digger bee), which occur in California and have been observed visiting O. basilaris var. basilaris (Grant and Grant 1979, p. 323). Pesticides affecting these pollinators can thus constitute a threat to Bakersfield cactus. The Environmental Protection Agency (Agency) released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The Agency anticipates releasing amended proposed interim decisions, and a national consultation with the Agency is pending. We cannot speculate as to the outcome of the consultation and final rulemaking, but it could have bearing on Bakersfield cactus's conservation status if the cactus requires cross-pollination by bees (USFWS, 2025).

**Stressor:** Invasive plants and herbivory (USFWS, 2025)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As discussed in the 2011 status review, invasive annual grasses are widespread in Kern County and are a threat to Bakersfield cactus (Service 2011, p. 25). Grasses compete with Bakersfield cactus for space and resources, especially soil moisture (Cypher and Fiehler 2006, p. 9). Invasive grasses also hinder the establishment of new cacti, contribute to increased fire frequency and intensity, harbor insects that may damage cacti through herbivory, and create a moist microclimate that may result in rotting of cactus pads (Service 2011, p. 25). Invasive grasses that impact Bakersfield cactus populations include wild oats (Avena spp.), bromes (Bromus spp.) and Saharan mustard (Brassica tournefortii) (Cypher et al. 2011, p. 15; Rogers, Warrick, and Labbé in litt. 2025, p. 4). During the summer months of 2020 and 2021, The Wildlands Conservancy staff noticed herbivory of Bakersfield cactus colonies at Wind Wolves Preserve (Wind Wolves) during outbreaks of grasshoppers (Melanoplus devastator and Dissosteira spurcata) and katydids (Tettigoniidae family) (Wind Wolves 2025, p. 16). These colonies correspond to Diversity Database occurrences #44 and 75–80 (Diversity Database 2025a; Diversity Database 2025b, pp. 41, 63–80). Insect damage varied in intensity, with some cactus clumps dying soon after the outbreaks, while others declined in health over two to three years and eventually died (Wind Wolves 2025, p. 16). Staff observed that insect invasions were more intense in areas with more residual dried annual grasses, which supports the idea that invasive grasses can harbor insects that may damage cacti (Wind Wolves 2025, p. 17). Additionally, there

appeared to be fewer insects and less severe damage to Bakersfield cactus in areas where livestock grazing had reduced grass density (Wind Wolves 2025, p. 17). Livestock grazing also reduces the biomass of grasses that compete with cactus colonies and reduces wildfire fuels (Cypher et al. 2011, p. 15). Therefore, appropriate levels of grazing seem to benefit Bakersfield cactus. However, intense grazing may result in trampling and other mechanical damage to Bakersfield cactus, so grazing should be properly implemented and monitored, and newly established cactus clumps can be protected with rocks, chicken wire, or rebar (Cypher et al. 2011, p. 16; Wind Wolves 2025, p. 11). (USFWS, 2025)

***Recovery***

**Reclassification Criteria:**
1) Secure and protect specified areas from incompatible uses A) 95 percent of occupied habitat on public lands; 75 percent of Bakersfield cactus clumps and 75 percent of occupied habitat in the Caliente-Bena Hills, Comanche Point, Kern Bluff, Sand Ridge, and Wheeler Ridge areas (addresses Listing Factor A) (USFWS, 2011);

2) A management plan has been approved and implemented for the recovery areas that includes survival of the species as an objective (addresses Listing Factors C and E) (USFWS, 2011);

3) Population monitoring in specified recovery areas shows: stable or increasing populations at all protected sites for a 5-year period (addresses Listing Factor E) (USFWS, 2011).

**Delisting Criteria:**
1) 90 percent of existing clumps and occupied habitat in the areas specified in the downlisting criteria (i.e. Caliente-Bena Hills, Comanche Point, Kern Bluffs, Sand Ridge, and Wheeler Ridge areas) and in the Fuller Acres, Cottonwood Creek, Granite Station, and Kern Canyon populations are protected (as defined in the downlisting criteria) (USFWS, 2011);

2) 100 or more clumps each in other populations north and south of the Kern River are protected (USFWS, 2011);

3) A management plan exists for all protected areas identified as important to the continued survival of the species; and (USFWS, 2011)

4) All protected populations show evidence of reproduction (USFWS, 2011)

**Recovery Actions:**
- 1. Protect populations within Bakersfield City limits in the Kern Bluff area and south of highway 178 (USFWS, 2011).
- 2. Work with willing land owners to establish a conservation easement or fee title to the property at the mouth of Kern Canyon (USFWS, 2011).
- 3. Complete the draft Department of Water Resources Habitat Conservation Plan (USFWS, 2011).
- 4. Conduct census of known populations and monitor the reproductive status of known populations (USFWS, 2011).

- 5. Determine suitable management methods for reducing nonnative annual grasses and increasing native perennials, including Bakersfield cactus, and communicate the benefits of such management to rangeland landowners (USFWS, 2011).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Protect existing habitat in the San Joaquin Valley for Bakersfield cactus. 2. Survey both extant and extirpated occurrences that have not been visited in the past few years to determine the status of these occurrences. Conduct yearly surveys at extant locations utilizing a standardized methodology to determine trends in the range-wide status as well as population/occurrence abundance. 3. Determine suitable management methods for reducing nonnative annual grasses and increasing native perennials, including Bakersfield cactus, and communicate the benefits of such management to rangeland owners. (USFWS, 2020)
- RECOMMENDATIONS FOR FUTURE ACTIONS Here we propose several management, conservation, and research recommendations which will aid in the recovery and conservation of Bakersfield cactus. Some of these recommendations have already been discussed in previous recovery documents (Service 1998, pp. 53–54; Service 2011, pp. 31–32; Service 2020, p. 4) and remain valid. 1. Habitat acquisition, management, and site-specific restoration. All native occurrences of Bakersfield cactus should be protected and secured through land acquisition, conservation easement, or other means. Additional suitable but unoccupied habitat should be protected and restored as future translocation sites. Adaptive and site-specific management of occurrences should be implemented under long-term management plans with a focus on maintaining suitable habitat conditions. Specifically, plans should address threats including competition from nonnative species, insect herbivory, trash dumping, and trampling by livestock, foot traffic, and off-highway vehicles. 2. Determine distribution and population dynamics through regular monitoring. Conduct range-wide status surveys at five-year intervals to quantify changes in Bakersfield cactus distribution and population trends. “Clumps”, which are groups of pads that are rooted at the same point, should be more precisely defined, such as by quantifying the area of the rooted point. Surveys should use Cypher et al. (2011, entire) methodology. Occurrences that have not been surveyed in the previous 10 years should be prioritized. Develop a plan to monitor abundance and population trends through regular surveying. Supplementary data may include habitat conditions, presence of invasive species and other threats, precipitation levels, temperature, and pollinator visitations. 3. Conduct genetic and morphological studies to clarify taxonomy and range. The genetic study conducted by Smith (2013, entire) should be repeated to clarify taxonomy, genetic partitioning within the metapopulation, and range. The study should include all known populations of Bakersfield cactus, Opuntia populations of intermediate morphology adjacent to the historical Bakersfield cactus range, and additional outgroups. In conjunction, a morphological study analogous to Zika and Wilson (2012, entire) should be conducted to determine whether physical characteristics can reliably distinguish Bakersfield cactus from other Opuntia. In addition to clarifying taxonomy and range, the genetic study results should be used to develop genetic management plans for each population, with a focus on populations that are actively augmented. 4. Continue translocation and population augmentation efforts under a genetic management plan. As translocation and augmentation efforts are all conducted through vegetative propagation of pads, a genetic management plan can help determine whether translocation should occur between genetically similar populations to avoid outbreeding depression or between dissimilar populations to increase diversity and representation. Extirpated occurrences should also be reintroduced. Additionally, an alternate translocation method through sexual propagation should be tested by collecting fruits, germinating mature seeds, caring for seedlings in a nursery, then planting at the translocation site when cacti are at a suitable size (Rogers, Warrick, and Labbé in litt. 2025, p. 4). This study can help determine whether seeds are

viable and, if successful, would increase genetic diversity. 5. Explore effectiveness of controlled burns and grazing on reducing invasive grasses. Appropriately managed grazing seems effective at reducing invasive grasses in Bakersfield cactus habitat. Further study the intensity, frequency, and timing of grazing that would confer the most benefit to Bakersfield cactus while minimizing trampling by livestock. Controlled low- to moderate-intensity burns may be another solution to the threat of invasive grasses. Conduct a feasibility test to determine the appropriate intensity and magnitude of fire for grass control and monitor health of Bakersfield cactus for adverse impacts. Compare grazing and controlled burns in terms of effectiveness at reducing invasive grasses, minimal impacts to Bakersfield cactus, cost to implement, and impacts on overall habitat and co-occurring species. 6. Clarify extent and population composition of recovery sites. Increased survey and translocation efforts have resulted in a greater number of known populations since the Bakersfield cactus recovery sites were defined in the Recovery Plan for Upland Species of the San Joaquin Valley (Service 1998, pp. 185–186). The boundaries of each recovery site should be clearly defined based on habitat surveys and aerial imagery to ensure that occurrences included in each recovery site appropriately represent a population. The recovery criteria should be reassessed based on this information (USFWS, 2025).

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# SPECIES ACCOUNT: *Oxypolis canbyi* (Canby's dropwort)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015) 2/25/1986

**Physical Description**

A perennial herb with strong, fleshy rhizomes. Plants have slender stems, often more than 1 m tall. Leaves are thin and quill-like. Herbage smells slightly of dill. From mid-August to October the plants bear compound clusters of small white flowers (sometimes tinged with red) (NatureServe, 2015).

**Taxonomy**

Molecular and morphological studies have shown evidence that the genus Oxypolis as currently circumscribed, including compound-leaved and rachis-leaved species, is not monophyletic: the rachis-leaved species of Oxypolis (which include O. canbyi) are transferred to their own genus, Tiedemannia (Feist and Downie 2008 and Feist et al. 2012) (NatureServe, 2015).

**Historical Range**

See Current

**Current Range**

Native to the coastal plain, from southwestern Georgia through South Carolina to southeastern North Carolina (mostly in the middle and inner Coastal Plain), and from eastern MD to (historically) Delaware (Weakley 2008). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Existing populations of Oxypolis canbyi are maintained mainly through asexual reproduction. This species is strongly clonal, reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. The flowers can be either unisexual or bisexual. Bisexual flowers may facilitate some self-pollination; however, the flowers are protandrous, which is indicative of some degree of outcrossing.; Existing populations of O. canbyi are maintained mainly through asexual reproduction. This species is strongly "clonalizing," reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. Perfect (bisexual) flowers are produced which may result in some self-pollination; however, the flowers are protandrous which may ensure some degree of outcrossing. The potential for outcrossing may be higher in those umbels which produce inner male flowers and outer female flowers. Outcrossing results in increased recombination and heterozygosity, thereby ensuring increased evolutionary potential. Sexual reproduction theoretically should act as a sort of evolutionary buffer enabling the species to survive environmental changes. This may not be the case in O. canbyi due to a possible high selfing rate and/or the isolation of small populations. Predation by the caterpillar of the black swallowtail butterfly (Papilio polyxenes asterius) may be a factor in reducing the sexual reproductive potential of O. canbyi. This caterpillar chews through the stems just below the inflorescence (NatureServe, 2015).

**Habitat Type**

Adult: Coastal Plains (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: O. canbyi has been found in a variety of Coastal Plain habitats prone to long periods of inundation, including pond cypress ponds, grass-sedge dominated Carolina bays, wet pine savannahs, shallow pineland ponds and cypress-pine swamps or sloughs. The largest and most vigorous populations reported occur in open bays or ponds which are flooded throughout most of the year and which have little or no canopy cover. Many sites are on a sandy loam or loam soil which is underlain by a clay layer. Based on county soil surveys, known soil types which support populations of O. canbyi include Rembert loam, Portsmouth loam, McColl loam, Grady loam, Coxville fine sandy loam, and Rains sandy loam. These soil types are similar in that they have a medium to high organic content, high water table, and are deep, poorly drained, and acidic. Historically, fire was a key element maintaining the open nature of the habitat at many O. canbyi sites. The following species are frequently found associated with O. canbyi: Ilex myrtifolia, Nyssa biflora, Taxodium ascendens, Pinus serotina, Stillingia aquatica, Rhynchospora tracyi, R. inundata, Manisuris rugosa, Rhexia aristosa, Polygala cymosa, Pluchea rosea, Lobelia boykinii and Hypericum denticulataum (NatureServe, 2015). Moderate ecological integrity of the community, tolerance ranges and site fidelity are inferred based on the variety of habitat in which the species can be found.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: The vectors of seed dispersal are not well understood, but at least some seed dispersal is by wind (USFWS, 1990).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Number of Populations:**

18 (17 natural and 1 introduced) (USFWS, 2022)

**Population Size:**
10,000 - 100,000 total individuals (NatureServe, 2015)

**Population Narrative:**
Historically, Canby's dropwort occurred in Delaware, Maryland, North and South Carolina, and Georgia. Today, Canby's dropwort only occurs in three states: Maryland, South Carolina, and Georgia. Further, Canby's range within these states has been reduced greatly overtime with Canby's dropwort being extirpated from 11 counties since the time it was listed. Habitat loss and wetland degradation combined with lack of habitat management through natural or prescribed fire has resulted in a continued decline of this species since its listing. To date, seventeen populations remain extant, and one population has been introduced, bringing the total number of extant populations to 18. Eleven Canby's dropwort populations are partially protected. Because many populations are owned by several landowners, protection and management of populations is difficult to achieve. Species experts defined a self-sustaining population as having a minimum of 1000 stems for five years. Currently, only five Canby's dropwort populations have 1000 stems or more. These populations occur in a small part of the species' former range in Maryland, South Carolina, and Georgia with populations being extirpated from Delaware and North Carolina. Because of existing and future threats and the limited number of populations that appear to be selfsustaining, this species still meets the definition of an endangered species. (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Wetland draining (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The most significant threat to Canby' dropwort is the direct loss or alteration of its rare wetland habitat. Ditching and draining of wetland areas, primarily for agriculture and silviculture, have reduced the frequency, depth and duration of surface water, lowered the groundwater table, and changed the vegetative composition in many areas of the mid-Atlantic coastal plain where the species historically occurred. Reducing surface water, changing soil moisture levels and lowering of the water table enables other plants to become established, modifies vegetative succession, and makes sites less conducive overall to the plant's growth and reproduction (Murdock and Rayner 1990). As a result, many sites have been invaded by shrubs and some sites have been planted in pine. Other sites have been dredged thus breaking the clay hardpan and draining the wetland (Murdock and Rayner 1990, Gaddy 2006) (USFWS, 2015).

**Stressor:** Fire suppression (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** On sites that are not actively disturbed by logging, ditching or dredging, habitat management is often needed to prevent encroachment of shrubs or trees that increase evapotranspiration, lower the water table and shade out Canby's dropwort. Periodic fires probably limited this encroachment under natural conditions but many sites are no longer

surrounded by pine forest subject to regular fires and few sites are managed with prescribed burning. An example is the Big Cypress Meadow which is owned by The Nature Conservancy and is the only site in North Carolina. Young trees, shrubs and maidencane have invaded much of the meadow and the number of Canby's dropwort has declined from as many as 10,000 plants in 1986 to only a few plants in recent years and none in 2006 (Gaddy 2006) (USFWS, 2015).

**Stressor:** Predation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:** Loss of plants
**Narrative:** Black swallowtail butterfly, grasshoppers, rabbits and rodents have all been known to damage/eat these plants (USFFWS, 2015).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** There is currently little regulatory protection of Canby's dropwort habitat. The U.S. Army Corps of Engineers (Corps) generally does not regulate dredge and fill activities in isolated wetlands because of a 2001 U.S. Supreme Court opinion. The 2001 opinion was issued in the Solid Waste Agency of Northern Cook County (SWANCC) v. the U.S. Army Corps of Engineers et al. and ruled in favor of SWANCC. The Corps' requirement for a Clean Water Act Section 404 permit to fill isolated wetlands to construct a landfill was overturned. The Corps had asserted jurisdiction on the isolated intrastate waters based solely on use by migratory birds (Findlaw 2007). Since that ruling isolated wetlands are generally not considered jurisdictional by the Corps. Therefore, there is no Federal nexus and consultation under section 7 of the Endangered Species Act is not required. Because Canby's dropwort grows only in isolated wetlands, there is currently no Federal regulatory control of actions that would affect its habitat. In South Carolina and Georgia, where almost all Canby's dropwort populations occur, there are no State laws that protect the isolated wetlands that provide Canby's dropwort habitat. Maryland and North Carolina, with one Canby's dropwort population each, do regulate isolated wetlands and therefore offer some protection to the habitat (Maryland Department of the Environment 2010, North Carolina Department of Environment and Natural Resources 2010). The Endangered Species Act prohibits the taking of endangered plants from Federal lands without a permit and regulates trade of listed plants. In addition, the Endangered Species Act prohibits the malicious damage or destruction of plants on Federal lands; and, their removal, cutting, digging, damaging, or destroying in knowing violation of any state law or regulation, including criminal trespass law. The State of Maryland prohibits taking of the species from private property without the landowner's permission and from State property without a permit and regulates trade in the species (Code of Maryland regulations 08.03.08). The State of North Carolina prohibits taking of the plant without a permit and the landowner's permission and regulates trade (North Carolina General Statute 19-B, 202.12-202.19). The State of Georgia prohibits digging, removal, or sale of State listed plants from public lands without the approval of the State management authority, and regulates sale or transport of State listed plants from private property (Georgia Wildflower Preservation Act of 1973). The State of South Carolina does not have any regulations that protect endangered plants on private land. However, regulations prohibit the unauthorized taking of plants from South Carolina Heritage Preserves and State Parks (South Carolina Code of Laws: Sections 50-11-2200, 50-11-2210, and 51-3-140) (USFWS, 2015).

***Recovery***

**Delisting Criteria:**
Canby's dropwort (Oxypolis canbyi) will be considered for delisting when there are at least 19 self-sustaining populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks. The populations should be distributed throughout the species' historic range. This recovery objective is considered an interim goal because of the lack of data on biology and management requirements of the species. As new information is acquired, the estimate of self-sustaining populations required for the species' survival may be readjusted. The recovery objective for 0. canbyi will be reassessed at least annually in light of any new information that becomes available (USFWS, 1990).

**Recovery Actions:**
- Conduct surveys and habitat assessments at all surveyed sites by Gaddy (2006) that are not routinely monitored to determine the species presence and to assess habitat quality (USFWS, 2015).
- Protect known Canby's dropwort populations on private lands with conservation easements or Wetland Reserve Program easements (USFWS, 2015).
- Assess moribund and extirpated sites as well as other isolated wetlands for suitable habitat and resource availability (USFWS, 2015).
- Improve our understanding of the relationship between precipitation (and other parameters) and Canby's dropwort population viability (USFWS, 2015).
- Determine objective, quantitative criteria for self-sustaining populations (USFWS, 2015).
- For populations confined within roadside or powerline right-of-ways, promote management actions that shift Canby's dropwort populations away from right-of-ways and towards the interior of adjacent wetlands (USFWS, 2015).
- Conduct demographic studies that further examine genetic variability, population structures, preproduction, and indeterminate growth factors (USFWS, 2015).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIVITIES 1. Protect known Canby's dropwort populations on private lands with conservation easements or Wetland Reserve Program Easements such as Monkey Bay in Clarendon County, SC, Perrion Pond (Burke County), Layfield Pond (Dooly County), Forrester Flats (Lee County), Roadside Park (Lee County), West Daniels Pond (Burke County), Greater Unadilla Pond (Dooly County), and Harmony Church Pond (Dooly County), GA. 2. Improve extant populations with fewer than 1,000 individuals by removing shrub/tree encroachment with prescribed fire, canopy thinning, or other techniques: a. Crosby Heritage Preserve, Colleton County, SC. b. Monkey Bay, Clarendon County, SC. c. Black Pond, Jenkins County, GA. d. Harmony Church Road, Dooly County, GA. e. Greater Unadilla Pond, Dooly County, GA. 3. Search for new populations on property that has suitable habitat within the species range. 4. Propagate and reintroduce Canby's dropwort by rhizome cuttings in a way that retains genetic diversity (e.g., taking rhizome cuttings from multiple individuals). 5. Collect seeds from all populations across the range to safeguard at a Center

for Plant Conservation Site, such as North Carolina Botanical Garden (NCBG). (USFWS, 2022)

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# SPECIES ACCOUNT: *Oxytropis campestris var. chartacea* (Fassett's locoweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened 09/28/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

**Physical Description**

A perennial herb with compound leaves and with herbage that is covered with dense, white-silky hairs, giving the plant a silvery-gray appearance. Spikes of rose-purple flowers, each about 2 cm long, bloom from late spring-early summer. (NatureServe, 2015)

**Taxonomy**

A distinct taxon. (NatureServe, 2015)

**Historical Range**

Historic populations in Bayfield and Waushara counties. (NatureServe, 2015)

**Current Range**

Restricted to small inland lakes at eight sites in central and northwestern Wisconsin: Waushara, Portage, and Bayfield counties. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2013)

**Lifespan**

Adult: Mean 1-4 years; up to 14 years (USFWS, 2013)

**Dependency on Other Individuals or Species**

Adult: Pollinated by bees and butterflies (USFWS, 2013)

**Breeding Season**

Adult: Flowers primarily late May to mid-June (USFWS, 2013)

**Other Reproductive Information**

Adult: Tippery (2015) found that seed germination in Fassett’s locoweed is highly dependent on physical damage to the seed coat, similar to many other plants in the Fabaceae (legume) family. In germination experiments, seeds with an intact seed coat had a very low rate of germination (about 7.8%) when compared to germination rates of seeds cut with a razorblade (61.1%) or seeds rubbed between sandpaper (71.1%). Seeds with thicker seed coats will persist longer in the seed bank, and since Fassett's locoweed relies on an extensive seed bank to recover from population crashes, this adaptation likely heavily contributes to the persistence of the species (Tippery 2015). Seed germination is also predicted by the ability of seeds to absorb water. During a trial, locoweed seeds that did not increase in size after being soaked in water overnight, were determined to have insufficient damage to the seed coat. Seeds that did absorb water had a germination rate of almost 100% (Tippery 2016). Ultimately, findings from these studies found that for germination to be successful, there must be absorption of water, which is not possible without scarification (nicking, breaking, softening, or weaking of the outer shell to speed up seed germination)(Tippery 2015, Tippery 2016). Tippery (2016) found that during the early stages of germination, Fassett's locoweed seedlings grow a root of 4 centimeters (cm)(1.6 inches (in)) or more in length. In germination experiments, seeds that were planted at the soil surface grew a hypocotyl (the part of the stem of an embryo plant beneath the stalks of the seed leaves and directly above the root) of 1 cm in length. In wild populations, there is no visible hypocotyl, and cotyledons (the embryonic leaf, first leaves to appear from a germinating seed) are usually visible just at the soil surface. This indicates that naturally seeds germinate at a depth of 1 cm (0.4 in) or more. In germination experiments, the effect of water depth on seedling establishment was tested using different length pipes to plant seeds. There were no observed differences in germination of seeds in 5 cm (2.0 in), 10 cm (3.9 in), or 15 cm (5.9 in) under water depth setups (USFWS, 2022).

**Reproduction Narrative**

Adult: Fassett's locoweed blooms primarily at the end of May through mid-June, although occasional plants bloom as late as November (Tracy Feldman, pers. obs., 2009-2012). The mean lifespan of Fassett's locoweed appears to vary from 1-4 years depending upon the life stage, the lake from which data were used, and the year data were collected, but the maximum can range to potentially over 14 years (Tracy Feldman, pers. comm., 2013). Seed production is variable, having the potential to vary from zero (even in a "reproductive" plant) to well over 10,000 seeds per plant, but actual numbers range from fairly low in small plants to several hundred (or even in the 1000s) of seeds for larger plants, on average (Tracy Feldman, pers. comm., 2012) (Feldman 2012). Data suggest that the seed banks on Plainfield and Pickerel Lakes are patchy but could be very large (Feldman 2010). While seed banks may be large, seed germination rates vary, and in the field germination rates may be low, from 50-95%; however, only 0-1% of intact seeds germinated in greenhouse and field germination experiments. Seeds appear to germinate in bands along the shoreline at some range of distances above the water line. (Feldman 2012) (USFWS, 2013)

**Habitat Type**

Adult: Palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Open gravelly lake (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Fluctuating lake levels (USFWS, 1991)

**Spatial Arrangements of the Population**

Adult: Pure stands to scattered individuals (USFWS, 1991)

**Environmental Specificity**

Adult: Narrow. Specialist with key requirements common. (NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from USFWS, 1991)

**Habitat Narrative**

Adult: Fassett's locoweed occurs on sandy or gravelly shorelines of small landlocked seepage lakes. It is apparently intolerant of competition and shading and dependent on lake level fluctuations to eliminate competition and maintain an open habitat. (NatureServe, 2015) In all cases, Fassett's locoweed occurs in areas which are completely exposed to sunlight or receive only partial shade from other species. Particularly along the open shorelines but also throughout the sandy lakeside habitat, the soil surface is subjected to extreme temperature fluctuations, high solar radiation, strong winds, and soil moisture stress. However, it is in these areas, where competition from other plant species appears to be very low, that Fassett's locoweed occurs in the densest colonies. (USFWS, 1991)

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 1991)

**Dispersal/Migration Narrative**

Adult: The mature fruits release numerous, small black seeds which have no evident adaptation for dispersal. As in many other plant species (Harper 1977, Johnson and Anderson 1986), the seeds of Fassett's locoweed probably tend to disperse in a clumped pattern around the parent plant. However, they may be moved short distances by wind, rain, or lake water during periods of inundation. (USFWS, 1991)

***Population Information and Trends***

**Population Trends:**

Fluctuating, but apparently increasing (USFWS, 2013)

**Species Trends:**

Fluctuating, but apparently increasing (USFWS, 2013)

**Population Growth Rate:**

Fluctuating (USFWS, 2013)

**Number of Populations:**

9 (USFWS, 2022)

**Population Size:**

Approximately 190,000 in 2012 (USFWS, 2013)

**Adaptability:**

Low (USFWS, 2013)

**Population Narrative:**

Of the 10 lakes that support Fassett's locoweed, the plant currently occurs in highest numbers (thousands) at four lakes; Pigeon, Mountain, Plainfield, and Pickerel lakes. Populations of Fassett's locoweed have fluctuated considerably over time. From 2009 to 2012, populations at Plainfield and Pickerel lakes have been stable or increasing due to increases in the number of seedlings (in the thousands) and small plants, most of which do not survive long enough to reproduce (Feldman 2009, 2010, 2011, 2012). Numbers of reproductive plants have decreased over the last four years at these two lakes. Predictions using projection matrix population models indicate that these populations have the potential to decrease in the near future (Feldman 2012). Up to 2000 plants were observed at Second Lake from 2006-2008, however the current population level is unknown. Populations number in the hundreds at Weymouth and Sherman (Marks) lakes. Very small populations (30 plants or less) have been consistently recorded at Lake Huron, Deer Print Lake, and Wolf Lake. (USFWS, 2013)Fluctuations in water levels maintain habitat but also determine population size from year to year. In one year, unusually high water levels may reduce populations to only a few plants and in the next year, lower water levels may result in thousands of plants (USFWS 2009). (NatureServe, 2015). Fassett's locoweed is a rare endemic species with a very limited distribution. Found in only a maximum of 9 sites (7 in central Wisconsin and 2 in northwest Wisconsin), any factor that impacts its habitat adversely could have major consequences (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Development (USFWS, 1991; 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Development, primarily construction of homes and cottages, was considered a significant threat in the Recovery Plan (USFWS, 1991). This threat has been reduced through acquisition of locoweed sites, conservation education and agreements, protective signage, designation of State Natural Areas which are managed to protect and maintain native landscapes. Residential development is still an issue for the Lake Huron site, although many homeowners at this site are caging plants, distributing information and occasionally pulling invasive weeds. (USFWS, 2013)

**Stressor:** Human impacts (USFWS, 1991; 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A county boat ramp on Pickerel Lake is a threat, along with fishing and swimming. A summer camp is also on this lake. In the past, Fassett's locoweed areas on camp property had been roped off (Darcy Kind, pers. comm., 2012), however no ropes were in place as of at least 2009. ATV use and hiking may trample plants. (USFWS, 1991; 2013)

**Stressor:** Other vegetation (USFWS, 1991; 2013)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Invasive plants, such as the non-native sweet clover can spread readily in open areas. It is considered a threat to recovering prairies, because it may compete with native species for resources or otherwise alter the edaphic conditions of the plant community (Eckardt 1987). The invasive orange hawkweed is quite abundant a few meters above the high waterline and grows in association with Fassett's locoweed in that zone. This species is of concern because of its possible allelopathic properties and the potential impact on Fassett's locoweed (Waller 1989). Trees and other vegetation may grow sufficiently to block out sunlight required by the locoweed. (USFWS, 1991; 2013)

**Stressor:** Nutrient enrichment (USFWS, 1991; 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Fassett's locoweed recovery plan (USFWS 1991) identified nutrient enrichment of shorelines supporting Fassett's locoweed resulting from run-off as a threat, as this may result in loss of habitat due to competition from other plant species that would not typically be able to compete with Fassett's locoweed in its nutrient poor habitat. (USFWS, 2013)

**Stressor:** Reduced groundwater levels (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fassett's locoweed is found on sandy-gravel lakeshores of seepage lakes, fed by groundwater, with fluctuating lake levels. Fluctuating lake levels are critical in maintaining suitable open shoreline habitat for the species. Aggressive plant competitors may be eliminated during periods of high water. Fluctuating water levels also help maintain low substrate fertility (preferred by the species) and distribute seeds within the site. The amount of available habitat at each site depends on current and recent lake levels. Generally, lower lake levels expose more shoreline area which provides more suitable habitat for the species, resulting in higher population numbers, especially of seedlings. However, continued low water conditions may decrease habitat due to succession. High lake levels which eliminate shoreline habitat, generally reduce overall population numbers. In addition, water level fluctuations within seasons may cause mortality of plants through submersion or desiccation (Tracy Feldman, UW-SP, pers. comm., 2012.) Lake levels may be affected by the use of high capacity wells used for crop irrigation. (USFWS, 2013)

**Stressor:** Herbivory (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Flowers have been eaten from a number of plants at one site, possibly by deer (WDNR, unpublished data). At Plainfield and Pickerel lakes in 2009-2012, Feldman observed racemes removed from Fassett's locoweed plants, potentially by deer. Insect herbivores may also affect Fassett's locoweed plants and seeds. At Plainfield and Pickerel lakes between 2009 and 2012, Tracy Feldman (UW-SP) observed caterpillars on racemes, spittlebugs on leaves, and occasional chewed leaves or racemes. At Pickerel Lake in 2012 he also observed holes in mature Fassett's locoweed fruits, reminiscent of weevil damage. (USFWS, 2013)

**Stressor:** Herbicides (USFWS, 1991; 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbicide and pesticide use is heavy in the agricultural areas. In addition, many of the lakes with Fassett's locoweed are lined with residential properties and lawns. Problems are possible from spray drift or run-off onto Fassett's locoweed habitat. Any decrease in the protective wooded buffer around each lake could result in increased overland flow of sediment-laden run-off into the water. (USFWS, 1991) The threat from herbicides is ongoing. (USFWS, 1991; 2013)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 9

**Delisting Criteria:**
Removal of Fassett's locoweed from the list of US. Endangered and Threatened Species will be considered when six populations are permanently protected and managed, and monitoring indicates the populations to be self-sustaining. (USFWS, 1991)

**Recovery Actions:**
- Protect and manage Fassett's locoweed at all sites with naturally-occurring populations. This includes the six extant [now 10 (USFWS, 2013)] populations as well as any new occurrences which might be found. Adequate protection will be accomplished not only through legal agreements with landowners but by increasing public awareness on the high-use lake shorelines. Education must be seen as integral to protection. (USFWS, 1991)
- Management to maintain appropriate habitat, including such activities as fencing populations in certain areas or removing invading, nonnative species, will be necessary at some sites. (USFWS, 1991)
- It is essential to conduct research which will contribute to recovery. Included here are seed bank research and genetic studies. (USFWS, 1991)
- Introduction of the species may become a future priority if protection of extant populations cannot be achieved. (USFWS, 1991)
- Land protection and site monitoring (USFWS, 2013)
- Site protection (USFWS, 2013)
- Population monitoring at Plainfield and Pickerel lakes (USFWS, 2013)
- Population augmentation (USFWS, 2013)
- Searches for new sites and potential reintroductions (USFWS, 2013)
- Actions to address threats due to continued low lake levels (USFWS, 2013)
- Pollinator studies (USFWS, 2013)
- Seed storage (USFWS, 2013)
- Seed bank studies (USFWS, 2013)

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# SPECIES ACCOUNT: *Paronychia chartacea* (Papery whitlow-wort)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 2/20/1987; Southeast Region (R4)

**Physical Description**

The papery whitlow-wort is mat-forming with many bright yellowish-green branches radiating flatly from a strong taproot (Kral 1983, Small 1933). The stems are 5 to 20 cm long and are wiry. The leaf blades are sessile, 1.5 to 3.0 mm long, ovate to triangular-ovate in shape, and strongly revolute. It has numerous small cream-colored to greenish flowers (Small 1933, FWS 1996) that produce a very thin-walled utricle (Kral 1983). There are two geographically isolated subspecies of this small herb: P. chartacea ssp. chartacea in central Florida and P. chartacea ssp. minima L. Anderson in the Florida panhandle. Much of the distinction between the two subspecies is a matter of degree (Anderson 1991). The P. chartacea ssp. minima is somewhat less pubescent than ssp. chartacea. There are also differences in their base stems, leaf width, and flower cluster (Anderson 1991). (USFWS, 1999)

**Taxonomy**

The papery whitlow-wort was first named by Small (1925) as Nychia pulvinata. In 1936 Fernald transferred the species to the genus Paronychia as P. chartacea because the name P. pulvinata was pre-empted (Anderson 1991). In 1991 Anderson formally described two geographically distinct subspecies, P. chartacea ssp. chartacea and P. chartacea ssp. minima. The subspecies P. chartacea ssp. minima was formally described by Anderson (1991), several years after P. chartacea had been listed as a threatened species. Because the entire species was listed as threatened, the newly described subspecies is also protected. (USFWS, 1999)

**Historical Range**

See current range/distribution.

**Current Range**

P. chartacea ssp. chartacea occurs in the Lake Wales Ridge in Highlands, Polk, Osceola, Orange, and Lake counties, Florida. P. chartacea ssp. minima occurs in the karst region of the Florida panhandle, Washington and Bay counties. (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Flowering and fruiting occur in late summer or fall (Anderson 1991) and the seeds mature in September or October (T. Race, Bok Tower Gardens, personal communication 1996). This species is a short-lived perennial (Anderson 1991 and observations by staff at the Historic Bok Sanctuary).

**Habitat Type**

Adult: Sand scrub/rosemary balds

**Environmental Specificity**

Adult: Narrow (Inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Papery whitlow-wort is most frequently seen in open, sunny gaps in rosemary balds within scrub vegetation (Abrahamson et al. 1984, Christman 1988, Menges and Kohfeldt 1995). At Archbold Biological Station, rosemary scrubs are found only on the higher ridges and knolls surrounded by scrubby flatwoods with dense oaks. The main soil types are St. Lucie and Archbold (Abrahamson et al. 1984), which are both well-drained white sands (U.S. Dept. of Agriculture, Soil Conservation Service 1989). The fire cycle in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982, Myers 1990). Rosemary scrub has abundant Florida rosemary (Ceratiola ericoides) and scrub oaks including Chapman oak (Quercus chapmannii), sand live oak (Q. geminata), Archbold oak (Q. inopina) and occasional sand pine (Pinus clausa). The open sandy areas of rosemary scrub contain small herbs and lichens (Abrahamson et al. 1984, Hawkes and Menges 1996). These gaps in the dense vegetation are more persistent in rosemary scrubs than in scrubby flatwoods (Hawkes and Menges 1996). Papery whitlow-wort also occurs in high pineland (upland longleaf pine vegetation, also called "sandhill") in the Walk in the Water tract of LWR State Forest (A. Cox, Florida Division of Forestry, personal communication 2002), at TNC's Crooked Lake Sandhill Preserve (B. Pace-Aldana, TNC, in litt. 2002), and at the Tiger Creek Preserve. In studies of the responses of plants to fire in rosemary balds, Johnson and Abrahamson (1990) and Ostertag and Menges (1994) identified two groups of scrub plants—those that resprout after a fire and those that return from seed. They found that papery whitlow-wort appeared in rosemary balds after fires, even though it had been rare or absent prior to the burn. This strongly indicates that papery whitlow-wort maintains seed banks in the soil, waiting for suitable germination conditions. Within about 9 to 12 years after a fire, papery whitlow-wort was displaced by Florida rosemary and reindeer lichens (Cladonia and Cladina) (Johnson and Abrahamson 1990). Some gap plants such as snakeroot and Highlands scrub hypericum disappear relatively quickly after fires and require large populations consisting of tens of thousands of plants to persist (Quintana-Ascencio and Menges 2000), but papery whitlow-wort persists longer after fire and it has many large populations over a relatively large geographic range, compared to other LWR endemic plants. The density of papery whitlow-wort increases in relation to available open space (Hawkes and Menges 1996; Menges and Kohfeldt 1995), so the species is most abundant in disturbed, sandy areas such as road rights-of-way and recently cleared high pine (Abrahamson et al. 1984; Christman 1988; Service 1996). Papery whitlow-wort can become very abundant after a fire or on disturbed sites such as along fire lanes or trails (Service 1996; Johnson and Abrahamson 1990) and is least likely of the federally-listed scrub plants to suffer local extirpations as open areas become covered by shrubs. Loose sand affects papery whitlow-wort. According to research by Petru and Menges (2004), "the demographic responses of the species to sand movements indicate that mobile sands create constantly shifting arrays of microsites that can influence post-dispersal seed germination, survival, and growth of Florida scrub herbs. Roadside habitats have more dynamic patterns of sand movement than natural gaps and may alter selection regimes important for demographic variation of endemic Florida scrub plants." Papery whitlow-wort persists on road edges in the absence of fire in the vegetation. These roadside sandy areas constitute habitats that are significantly different from the bare areas within the vegetation, and may be less suitable for persistence of the species. This research bolsters the already-substantial evidence that prescribed fire is essential to maintain Florida scrub vegetation and its biota, including other federally listed plants and animals. Management for papery whitlow-wort requires burning regimes that mimic the natural fire cycles of rosemary scrub. Relationships among fire, open space, and plant distributions within a xeric scrub are complex and need to be studied further (Hawkes and Menges 1996). Management practices for rosemary scrub should include fire at intervals suitable for a variety of plants and animals, rather than at intervals optimized for just a single species (Hawkes and Menges 1996; Quintana-Ascencio et al. 2003).

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

< 24 EORs ( Element Occurrence Records) (USFWS, 2021)

**Population Size:**

2500 - 10,000 individuals (NatureServe, 2015)

**Adaptability:**

Found in disturbed sites; can tolerate and probably promoted by fire. (NatureServe, 2015)

**Population Narrative:**

Papery whitlow-wort occurs on the Lake Wales and at least one smaller nearby ridge (Kral 1983), in Highlands, Polk, Osceola, Orange, and Lake Counties (Anderson 1991). It is present on the small ridge at the Lake McLeod tract of LWR National Wildlife Refuge, but not on the Bombing Range Ridge on Avon Park Air Force Range. On the LWR, it is present in essentially all of the scrub conservation lands. Since the last comprehensive survey (Schultz et al. 1999), it has been found in high pineland at the Walk in Water tract of LWR State Forest (Anne Cox, LWR State Forest, personal communication 2002). It is also present in high pineland on the Tiger Creek Preserve, owned by The Nature Conservancy. The northern range limit of papery whitlow-wort is in Lake County, where it occurs on the north side of Lake Louisa at Crooked River Preserve, owned by the Lake County Water Authority. It was possibly present at a nearby site, Schofield Sandhill, which had been proposed for acquisition under the Florida Forever program, but the acquisition proposal did not come to fruition. The only site on conservation lands in Orange County (also at the northern range limit) is the small Shadow Bay Park (formerly Lake Cane-Marsha Park) near where the Florida Turnpike crosses Interstate 4. The species was reported from localities in western Orange County, but the area has since become urbanized, and there are few if any opportunities for setting aside conservation lands in this area. The only papery whitlow-wort site in Osceola County for that has been proposed for State acquisition is at Lake Davenport, in the northwestern corner of the County. It has not been purchased (Florida Natural Areas Inventory 2005). Papery whitlow-wort is present on essentially all conservation lands with scrub on the LWR in Polk and Highlands Counties. The southernmost sites on conservation lands are Gould Road (part of the LWR Wildlife and Environmental Area operated by the FWC) and Archbold, both in Highlands County south of Lake Placid (Schultz et al. 1999). During 2003, the Florida Fish and Wildlife Conservation Commission and Archbold Biological Station purchased adjoining portions of a ranch that bordered the Biological Station's preserve to the west. The recently-acquired land provides an important buffer for Archbold, and it protects additional habitat for this species, both occupied and restorable. Although FNAI data provide the best available overall view of the distribution of this species, intensive local inventories add important detail. The LWR State Forest is represented in the FNAI database by nine element occurrences, yet the Arbuckle tract of the Forest has 188 records of this plant in its GIS database, based upon an inventory by K. DeLaney in 1988 (data provided by A. Cox, LWR State Forest). Of the 188 records, 23 represented more than 100 individuals. Archbold Biological Station has not monitored this plant because it thrives in fire lanes that usually do not have exotic plant problems (E. Menges and M. Deyrup, Archbold, personal communication 1995, in Service 1996). The propensity of this species to occupy fire lanes, roadsides, and other artificially disturbed areas is a primary conservation concern for the papery whitlow-wort, because it tends to be far more abundant in such disturbed areas than within the vegetation itself. This situation was researched by Petru and Menges (2004), and they confirmed that prescribed fire is essential to create and restore open, sandy habitat for this and other plants. The papery whitlow-wort occurs in association with several other federally listed species: in scrub, Florida bonamia, Highlands scrub hypericum, wireweed, Florida perforate cladonia, snakeroot, and scrub blazing star. In high pineland at the Tiger Creek Preserve, pygmy fringe tree, pigeon wings, scrub buckwheat, Britton's beargrass, scrub plum, and Carter's mustard. Papery whitlow-wort is the most abundant and widespread of the listed LWR scrub and high pineland plants, and it has benefited greatly from acquisition of conservation lands in its range. Like several other scrub species, including Highlands scrub hypericum, is particularly abundant in human-disturbed areas such as road edges and fire lanes. Researchers based at Archbold Biological Station are interested in finding ways to lessen these plants' dependence on such artificial habitats through restoration of fire regimes.

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** For subspecies chartacea, about 30% of FNAI EORs are not protected from threats that are range-wide in scope. Fire suppression is pervasive at unprotected sites and gradually alters habitat over a period of years. Habitat loss through agricultural and residential development is immediate, ongoing, and cumulative. Seventy percent of FNAI EORs occur within one of the 26 managed areas listed in C(1)(d) above. Loss of populations off the LWR in Orange, Polk, and Glades Counties would constitute a significant curtailment of the historic range of chartacea (Turner et al. 2006). Some of these sites may already have been lost. For subspecies minima, it is unknown how many populations have already been lost and its historical range has apparently not been documented. Eight of 12 extant sites appear to be in imminent danger of being lost; all are on privately owned land and could be destroyed if development or habitat modification occurs on those lands. For both subspecies a range-wide survey is needed to determine the current status of populations and the threats to each. (USFWS, 2008)

**Stressor:** Inadequacy of existing regulatory mechanisms
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Papery whitlow-wort is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. Property owners are not prohibited under this law from destroying populations of listed plants nor are they required to manage habitats to maintain populations. Existing federal and state regulations prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. In addition, state regulations are less stringent than federal regulations on land management practices that may adversely affect populations of listed plants. Existing regulatory mechanisms are inadequate to protect this species. (USFWS, 2008)

**Stressor:** Inadequate management (fire or mechanical disturbance)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Maintenance of viable populations of imperiled plant species depends largely on the determination of the appropriate management regime of populations on managed areas. For subspecies chartacea, inadequate use of fire or the use of mechanical treatments as a surrogate for fire may reduce population sizes or adversely affect demographic performance. For subspecies chartacea, appropriate management means burning Florida rosemary scrub often enough to maintain large gaps within the rosemary shrub matrix. In the absence of data on the biology and autecology of subspecies minima, its management eeds cannot be determined. The preferred habitat of subspecies minima on the margins of karst ponds suggests that disturbances other than fire may be required for the maintenance of its populations. (USFWS, 2008)

***Recovery***

**Reclassification Criteria:**
Not relevant. (USFWS, 1999)

Recovery Priority Number: 8

**Delisting Criteria:**
I. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95% probability of persistence for 100 years. (USFWS, 1999)

2. When these sites, within the historic range of P. chartacea, are adequately protected from habitat loss, degradation, and fragmentation. (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support P. chartacea. (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

**Recovery Actions:**

- Determine current distribution of P. chartacea. Some portions of P. chartacea's range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, has been isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of P. chartacea. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor populations of P. chartacea. Develop monitoring protocol to assess population trends for P. chartacea. Develop a quantitative description of the population structure of P. chartacea. (USFWS, 1999)
- Provide public information about P. chartacea. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about P. chartacea. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. chartacea and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- A taxonomic study evaluating the distinctiveness of the two subspecies should be conducted. (USFWS, 2008)
- A study of the reproductive biology of the two subspecies should be conducted to determine the degree of floral dimorphism/sexual gender and sex ratios of populations. (USFWS, 2008)
- For P. c. chartacea, surveys should be conducted to assess the status of the FNAI EORs that occur on unprotected sites and to evaluate the feasibility of protecting additional populations. Following Turner et al. (2006), extant parcels in the Green Swamp and at Fisheating Creek, Avon Park Lakes, Lake Davenport and other sites should be targeted for acquisition. Acquisition of these sites would also extend protection to other federally listed plants. (USFWS, 2008)
- For P. c. minima,It is unclear how well existing FNAI EORs reflect the historic range of the taxon. It is possible that additional surveys of areas with appropriate habitat are needed. The possibility of acquiring additional populations also needs to be assessed. (USFWS, 2008)
- Habitat maintenance requirements of P. c. minima need to be investigated. (USFWS, 2008)
- For both subspecies, the minimal monitoring should be establishment of level 2 monitoring (sensu Menges and Gordon 1996) to track changes in population sizes over time. Level 2 monitoring requires that surveys be repeated at defined intervals (e.g., annually, biannually, every five years, or both before and after imposition of management treatments) and that

surveys take place within well-defined areas (e.g., within plots small enough to be searched thoroughly within a minimum of effort). ABS' s Population Dynamics of Endemic Plants (PDEP) project was designed as a model of level 2 monitoring that can be deployed by other agencies. Presence/absence data (level 1 monitoring sensu Menges and Gordon 1996) or the periodic accumulation of GPS points cannot provide meaningful data for determining population trends or for quantifying responses to prescribed fire or other management activities.(USFWS, 2008)

- To conduct population viability analyses, detailed demographic data (level 3 monitoring sensu Menges and. Gordon 1996) should be collected from multiple populations of both subspecies. These data need to be collected across the full geographic range of both subspecies, from populations in contrasting habitats (e.g., rosemary scrub vs. roadsides for subspecies chartacea, pond margins vs. sandhill for subspecies minima), and in sites with differing management histories. (USFWS, 2008)
- Studies should be conducted to understand the genetic diversity of both subspecies; this may aid in the identification of new acquisition needs. (USFWS, 2008)
- Where monitoring is being conducted, data should be collected on fire management activities to aid in the interpretation of trends and identifying the most favorable treatments. (USFWS, 2008)
- A revised recovery plan should be developed to address the existence of two subspecies with separate geographic ranges and their potential need for differing management practices to ensure recovery. (USFWS, 2008)
- Habitat for P. c. chartacea needs to be maintained through burning Florida rosemary scrub within the modal fire return interval defined by other gap specialists and by Florida rosemary (Menges 2007). (USFWS, 2008)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Conduct surveys for P. c. var. minima in areas with appropriate habitat and unknown occupancy to assess the possibility of additional populations and help identify the historic range of the variety. This could include a habitat suitability analysis to help guide surveys. • Purchase for conservation or work with private landowners to develop conservation agreements for unprotected lands with P. c. var. minima. • Manage Florida rosemary scrub habitat for P. c. chartacea through prescribed fire within a fire return interval of 10 to 30 years (Menges et al. 2019). • Investigate the habitat maintenance requirements of P. c. minima, particularly with respect to hydrology. • Institute or continue Level 1 monitoring for P. c. var. chartacea between August and November when plants are most abundant. • Conduct more intensive monitoring of P. c. var. minima. However, its short lifespan and the very dynamic nature of pond hydrology at most sites will make this monitoring challenging. Understanding seed dormancy in P. c. var. minima will be key to understanding its limits with respect to hydrological variation. • Conduct population viability analyses, including detailed demographic data (level 3 monitoring sensu Menges and Gordon 1996) collected from multiple populations of both subspecies. Collect data across the full geographic range of both varieties, from populations in contrasting habitats (e.g., rosemary scrub vs. roadsides for subspecies P. c. var. chartacea, pond margins vs. sandhill for subspecies P. c. var. minima), and in sites with differing management histories. Relate demographic research on P. c. var. chartacea to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness. Couple such data for P. c. var. minima with current and historical data on pond hydrology. • Conduct studies to understand the genetic diversity of both varieties; this may aid in the identification of new acquisition needs. • Conduct a study of the reproductive biology of the two varieties to determine the degree of floral dimorphism/sexual gender and sex ratios of populations. (USFWS, 2021)

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# SPECIES ACCOUNT: *Paronychia congesta* (Bushy whitlow-wort)

***Species Taxonomic and Listing Information***

**Listing Status:** Proposed Endangered

**Physical Description**

Bushy whitlow-wort is a perennial herbaceous plant of the Carnation Family (Caryophyllaceae). Correll (1966) described Paronychia congesta as a new species, based on specimens collected about 1.6 kilometers (km) (1.0 miles (mi)) south of Thompsonville in northwest Jim Hogg County, Texas. (Thompsonville is now a dispersed rural community (Garza 2020); the former town site is uninhabited). Individuals have multiple stems, from 6 to 24 centimeters (cm) (2.4 to 9.4 inches (in)) tall, radiating from a perennial caudex (woody rootstock) (see cover photograph and Figure 1.b). The narrow, stemless, sharply-pointed leaves are arranged in opposing pairs, often appressed to the stems; leaves and bracts are crowded and overlapping at the bases of stems and primary branches. Each leaf is 4 to 7 millimeters (mm) (0.2 to 0.3 in) long and 0.5 mm (0.02 in) wide; stipules are long, thin, silvery, membranaceous, hairless, and about as long as the leaves. The stems, leaves, and sepals are covered with dense, short, spreading hairs. Dense clusters of 7 to 28 tiny flowers are arranged in blueish-green cymes at the tips of stems (Figure 1.a). Bisexual flowers are subtended by bracts, lack petals, and have 5 petal-like calyx lobes that are lemon-yellow on the inner side and fade from green to reddish-brown on the outer side. Calyx lobes are 2.5 to 3.1 mm (0.10 to 0.12 in) long and are longer than bracts; each lobe has a hooded tip from which emerges a stiff, short awn 0.5 to 0.7 mm (0.02 to 0.3 in) long. Each flower has 2 to 5 stamens and a single pistil with two styles united nearly to the stigmas. Fertilized flowers can produce a bladder-like fruit, called a utricle, with a single ovoid seed 0.8 to 0.9 mm (0.03 to 0.04 in) long (USFWS, 2023).

**Taxonomy**

There are about 110 species of Paronychia, of which 26 occur in North America (Hartman et al. 2005a, p. 30). Turner (1983a) reviewed the taxonomic status of the Texas species of Paronychia. He observed that P. congesta was most similar to P. jamesii, a more common species that is widely distributed from west Texas and Arizona to Nebraska and Wyoming; he concluded that they are distinct taxa, based on the geographic separation of their ranges (p. 10) and the more congested inflorescences, gradually tapered calyx lobes, and non-divergent awns of the former species (p. 18). Another very rare endemic Paronychia, P. maccartii, occurs in Webb County just 16 km (10 miles) west of the P. congesta type location. However, these species are not closely related and are easily distinguished in the field (see Table 1); furthermore, P. maccartii inhabits loose, sandy soils, while P. congesta is found on calcareous rock outcrops (Turner 1983b, p. 3). A phylogenetic study based on a relatively small sample of 21 taxa within the tribe Paronychieae indicated that the genus Paronychia, as currently circumscribed, may be polyphyletic (Oxelman et al. 2002, p. 231). Nevertheless, P. congesta continues to be recognized as a unique, valid species (USFWS, 2023).

**Current Range**

The two documented populations of bushy whitlow-wort occupy nearly barren, exposed, sloping outcrops of calcareous rock and/or indurated caliche along the boundary of the Goliad and Catahoula geological formations, known locally as the Bordas Escarpment. The species is likely to be a geo-endemic that is uniquely adapted to the soil or geological features that occur there.

Some observers describe the unique substrates of occupied sites as calcareous tuff, which occurs in discrete sites along the Goliad/Catahoula boundary. We developed a potential habitat model based on the distribution of the geological, soil, and slope features of occupied sites to predict where else the species may occur. This model indicates that a range of thousands to tens of thousands of hectares of potential habitat exist in south Texas; the largest clusters of potential habitat are in Webb, Jim Hogg, Zapata, and Starr counties. Based on available botanical surveys, we estimate that less than 1 percent of this potential habitat has been surveyed by botanists qualified to identify the species (USFWS, 2023).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

2 (USFWS, 2023)

**Population Narrative:**

The Texas Parks and Wildlife Department (TPWD) Natural Diversity Database (TXNDD) maintains geographic and population data of plant and animal species of conservation concern in Texas. This data is contributed and used by many entities involved in conservation, including TPWD and other state agencies, federal agencies, academic researchers, environmental consultants, non-profit conservation organizations, and private individuals. Data for each species is organized by standard geographical units for populations and habitats called “Element Occurrences” (EOs), which are defined as “areas of land and/or water in which a species or natural community is, or was, present” (NatureServe 2002, p. 1). EOs are displayed as points, lines, and polygons buffered by their estimated geographic precision. The reported populations occur or occurred within, but not necessarily throughout, the buffered EO points, lines, and polygons (see Figure 3). The recommended minimum separation distances between EOs is 1 km (0.6 mi) for gaps of unsuitable habitat or unoccupied suitable habitat. Damude and Poole (1990) and Strong and Williamson (2015) refer to EO 1 as the “five-acre site”, and EO 2 as the “15-acre site”. These EOs, as mapped by TXNDD, occupy 3.1 hectares (ha) (7.7 acres (ac)) and 18.0 ha (44.4 ac), respectively; however, EO 2 is bisected by highway FM 649, which converted about 1.6 ha (4.0 ac) of habitat to pavement and graded right-of-way. Therefore, the total area of these EOs is about 19.5 ha (48.1 ac). The two EOs are separated by 2.05 km (1.27 mi). (USFWS, 2023)

***Threats and Stressors***

**Stressor:** Land use changes
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** We are not aware of any current land use changes within the two known occupied habitats of bushy whitlow-wort since they were first discovered in 1963 and 1987; however, see the discussion of potential wind energy development below. These privately owned properties have been used for livestock grazing for many years. We have no information on the species' palatability to cattle. However, due to its small stature, it offers very little nutritional reward to cattle, particularly when larger palatable plants are relatively abundant. Cattle are not attracted to the barren rock outcrops where the species occurs, so the impact of trampling should be negligible. In any case, the species has persisted in its current locations despite decades of grazing. We conclude that cattle grazing is not a significant threat to the species' survival. The very shallow Zapata and Cuevitas-Randado association soils of occupied populations are underlaid by indurated caliche along steep slopes; since they are not suitable for row crops or other agricultural uses, we do not anticipate habitat losses due to a change in agricultural use. One of the two EOs was bisected by highway FM 649 in 1954; we estimate that the highway construction and ROW destroyed about 1.63 ha (4.03 ac) of habitat. We are not aware of planned highway construction that would affect the occupied habitats. Due to the low population density in rural Jim Hogg County and the distance to population centers, currently there are no projected habitat losses to urban and residential development.

**Stressor:** Few known populations
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Only two EOs of bushy whitlow-wort have been documented, with a combined area of 19.5 ha (48.1 ac). The populations are separated by only 2.1 km (1.3 mi). A single event, such as prolonged drought, or a single development project could easily destroy a large portion of the species' known remaining resources. The close proximity of the two EOs increases this vulnerability. We conclude that the small number of bushy whitlow-wort populations (lack of redundancy) is a current, severe threat to the species. Demographic consequences of small population sizes Small, isolated populations are more vulnerable to catastrophic losses caused by random fluctuations in recruitment (demographic stochasticity) or variations in rainfall or other environmental factors (environmental stochasticity) (USFWS 2016, p. 20). In addition to population size, it is likely that population density also influences population viability, since reproduction requires genetically compatible individuals to be clustered within the forage ranges of the species' pollinators. Surveyors have reported a population size of up to about 2,000 individuals, on single occasions, for each of the two known EOs of bushy whitlow-wort. Compared to the estimated MVP of 1,500 individuals, this might suggest that these populations are relatively resilient. However, on other occasions, surveyors found as few as 4 and 100 individuals at the two EOs. We do not know if these lower numbers represent actual population fluctuations, or if the surveyors were unable to detect live, dormant individuals. Due to the infrequency of censuses, we cannot assess current population sizes or trends. We conclude that the demographic consequences of small population sizes present a potential threat of unknown immediacy, severity, and extent (USFWS, 2023).

**Stressor:** Climate Change
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: • It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; • it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; • it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; • it is very likely that the frequency, intensity, and/or amount of heavy precipitation events will increase in mid-latitude land masses; and • it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. Similarly, the U.S. Global Climate Research Program (USGCRP) Fourth National Climate Assessment (USGCRP 2017) reports that average annual temperatures from 1986—2016 have increased in the Southern Great Plains (including the range of bushy whitlow-wort) by 0.42° C (0.76° F), compared to the 1901—1960 baseline (USGCRP 2017, Chapter 6, Table 6.1). Average annual temperatures in the Southern Great Plains are projected to increase by 2.65° to 4.69° C (4.78° to 8.44° F), under moderate and high emission scenarios, respectively, by the late 21st century (USGCRP 2017 Chapter 6, Table 6.4). By the end of the 21st century, under the highest emissions scenario, precipitation in Jim Hogg and surrounding counties is projected to decrease from 10 to 20 percent during the winter and spring; summer and fall precipitation changes in this region are projected to be smaller than natural variations (USGCRP 2017 Chapter 7, pp. 15–16 and Figure 7.5). However, the frequency of heavy precipitation events in the Southern Great Plains has increased from 1901 to 2016 and 1948 to 2016 (USGCRP 2017 Chapter 7 pp. 5–9 and Figures 7.2–7.4) and is projected to continue to increase under moderate and high emission scenarios.

***Recovery***

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Parvisedum leiocarpum* (Lake County stonecrop)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A low annual herb, generally only 1-3.5 cm tall, with fleshy leaves that fall off the stem by flowering time. Flowers (April-May) are small and yellow. (NatureServe, 2015)

**Taxonomy**

USFWS tracks as Parvisedum leiocarpum (9/93). (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Known from only a small number of populations within a 10-square-mile area. This species occurs on more or less level sites in shallow depressions that retain water seasonally. Known microhabitats include Northern Basalt Flow and Northern Volcanic Ashflow vernal pools (Sawyer and Keeler-Wolf 1995), low areas in meadows and gravelly flats, and hollows in exposed rocks. A few plants were found on a man-made berm within a flat area that supported a large population. Substrates on which S. leiocarpa occur frequently are of volcanic origin and often are gravelly (Patterson 1986). The species occurs at elevations of 518 to 793 meters (1,700 to 2,600 feet). (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Terrestrial, palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Vernal pools and margins (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits margins of vernal pools and depressions in bedrock which act as shallow vernal pools and volcanic substrates (NatureServe, 2015).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Population Narrative:**

At least 50% of the known populations have been destroyed in the last 60 years. Decline of 50-70% (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and individuals.

***Threats and Stressors***

**Stressor:** Altered hydrology (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Altered hydrology is listed as a threat to this species (USFWS, 2009).

**Stressor:** Road maintenance/widening (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Road maintenance/widening is listed as a threat to this species (USFWS, 2009).

**Stressor:** Agricultural land conversion (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Agricultural land conversion is listed as a threat to this species (USFWS, 2009).

**Stressor:** Off-highway vehicle use (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Off-highway vehicle use is listed as a threat to this species (USFWS, 2009).

**Stressor:** Trampling by cattle (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Trampling by cattle is listed as a threat to this species (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The final rule finds inadequacies with the Federal Clean Water Act, the California Environmental Quality Act, and the California Endangered Species Act in addressing threats to

this species (USFWS, 2009).

**Stressor:** Likelihood of Stochastic Extinction (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Extinction
**Narrative:** The combination of restricted range, few populations, and highly specific and vulnerable habitat makes this species vulnerable to destruction of all, or a significant part, of any population from random events such as floods or droughts (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Climate change is listed as a possible threat to this species (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2C

**Delisting Criteria:**
Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species localities distributed across the species geographic range and genetic range are protected. Protection of the extreme edges of the population protects the genetic differences that occur there. Reintroduction and introductions must be carried out and meet success criteria. Additional localities that are detected (and determined essential for recovery goals) are permanently protected. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through atleast one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

Adaptive habitat management and monitoring. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.). Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average and below average local rainfall, a multi-year drought, and a minimum of 5 years post drought monitoring. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2009).

Status surveys: Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average rainfall, a multi-year drought and a minimum of 5 years of post drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning must be ameliorated or eliminated (USFWS, 2009).

Research: Research actions necessary for the recovery and conservation of the covered species have been identified. Research actions on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document as previously described in sections 1A-E. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

Participation and outreach: Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

**Recovery Actions:**

- Protect habitat. Currently none of the known localities of the species are protected. Preservation of Zone 1 core area should be pursued to preserve known localities (USFWS, 2009).
- Control erosion (USFWS, 2009).
- Conduct research at as many of the extant localities as possible (USFWS, 2009).
- Collect seeds for future introduction and/or reintroductions into suitable habitat (USFWS, 2009).
- Formally change the name in the Code of Federal Regulations from Parvisedum leiocarpum to Sedella leiocarpa (USFWS, 2009).
- Correct the downlisting criteria, if necessary, to also apply to the Dry Lake core area (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the Lake County stonecrop. Some of these recommendations have already been discussed in the Recovery Plan (Service 2005, pp. III-5–III93) and the 2009 status review (Service 2009, pp. 18–19) and remain valid. 1. Protect habitat. Currently, none of the known localities of this species are protected.

Preservation of suitable habitat within the Boggs Lake-Clear Lake and Dry Lake Core Areas should be pursued to preserve known localities. 2. Control erosion. Erosion control measures at Manning Flat should be implemented because soil loss is making the habitat unsuitable. 3. Conduct research at as many of the extant localities as possible to implement research recommendations outlined in the 2005 Recovery Plan. The following research should be prioritized: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will improve our understanding of potential threats to the species and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine if it is affected by breeding system limitations such as low reproductive rate, inbreeding depression, or loss of genetic diversity. 4. Collect seeds for future introduction and/or reintroduction into suitable habitat. 5. Formally change the name in the Code of Federal Regulations from Parvisedum leiocarpum to Sedella leiocarpa. 6. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the Lake County stonecrop and develop stepdown success parameters, if appropriate, that reflect the species' life history and narrow range to help us better understand the status of the species (USFWS, 2024).

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# SPECIES ACCOUNT: *Pedicularis furbishiae* (Furbish lousewort)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Northeast Region (R5) (USFWS, 2015). Reclassified to Threatened June 9, 2023.

**Physical Description**

A perennial herb in the Scrophulariaceae (snapdragon family) that produces 1 or more flowering stems, up to 1 m tall, from a basal rosette of leaves. Leaves are deeply divided and have toothed edges. Yellow, 2-lipped flowers bloom in a spike at the top of the flowering stalk from mid-July to late-August. (NatureServe, 2015)

**Taxonomy**

The genus Pedicularis contains over 600 species, most of which are common in tundra, alpine, and subalpine floras in Asia, Europe and North America (Robart et al. 2015, p. 229). The center of Pedicularis species diversity is in the northern Himalayas, China, and Siberia. The Furbish's lousewort has the most restricted distribution of any species of the genus Pedicularis (Gawler 1983, p. 28). The Furbish's lousewort (Pedicularis furbishiae Sereno Watson 1882) is a member of the broomrape family, Orobanchanceae (formerly from the snapdragon family Scrophulariaceae)(Olmstead et al. 2001). The taxonomic identity of the Furbish's lousewort as a distinct species is unquestioned, but its taxonomic position within the genus Pedicularis is not certain (Macior pers. comm. in Stirrett 1980, p. 21) and has been a topic of considerable conjecture and discussion (Gawler 1983, pp. 28-29, Robart et al. 2015, p. 253). Dr. Peter Nelson at the University of Maine at Fort Kent and Rick Ree at the Field Museum in Chicago are continuing genetic research to identify the "sister species" and document the unique phylogeny of the Furbish lousewort. Dr. Nelson has collected samples at numerous subpopulations in Maine and New Brunswick to evaluate the genetic structure and variation within the Furbish's lousewort metapopulation. Similar to the electrophoretic genetic results published by Waller et al. (1987, entire), preliminary results indicate low genetic variability in the Furbish's lousewort population (P. Nelson email November 11, 2017). Additional results will be available in 2018. (USFWS, 2018)

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to the Saint John River Valley of northern Maine and adjacent New Brunswick. The entire range of Pedicularis furbishiae covers 225 km of the St. John River, extending from a point 1.5 miles upriver of the confluence with the Big Black River in Aroostook County, Maine to the town of Andover, New Brunswick in Canada. (NatureServe, 2015)

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (outcrossing) and asexual (USFWS, 1991)

**Dependency on Other Individuals or Species**

Adult: Bombus vagans, a common bumblebee which also forages on other co-flowering species such as red clover, is the exclusive pollinator of Pedicularis furbishiae (Macior 1978a). (USFWS, 1991)

**Breeding Season**

Adult: July to August (USFWS, 1991)

**Reproduction Narrative**

Adult: Pedicularis furbishiae is a herbaceous perennial which takes several years to reach sexual maturity. Reproduction is solely by seed. Louseworts flower from mid-July to mid- August, with seeds dispersing in early September. Recent experiments (Waller et al. 1988) have shown that selfed and outcrossed flowers are equally successful at setting capsules, contradicting Macior's (1978) conclusion that Pedicularis furbishiae is self-incompatible. The success of capsule maturation varies widely among populations and years. On average an inflorescence will produce 7—17 capsules, each averaging 25 seeds (Menges et al. 1985, 1986; Gawler et al. 1986). (USFWS, 1991)

**Habitat Type**

Adult: Palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Herbaceous wetland, riparian, scrub-scrub wetland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: High soil moisture; flooding is essential for habitat (USFWS, 1991)

**Geographic or Habitat Restraints or Barriers**

Adult: Ice scouring and succession can limit habitat; low vegetative cover (USFWS, 1991)

**Environmental Specificity**

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (USFWS, 1991)

**Habitat Narrative**

Adult: This species inhabits the riverbanks of the Saint John River, mostly in the steep, highly diverse shrub- or forb-dominated zone between open river cobbles and boreal forest. The habitat is notable for the high frequency and the severity of disturbance by ice scour and vertical river bank slumping. (The Saint John River drains one of the largest watersheds in the northeast, yet it has relatively little headwater storage, making it subject to dramatic seasonal and longer-term fluctuations in water level and to severe ice-jams.) The zone in which Pedicularis furbishiae occurs bears the brunt of regular ice scouring - tree establishment does not occur here and vegetation cover tends to be moderate. Plants grow on glacial lacustrine or till deposits. (NatureServe, 2015) Pedicularis furbishiae is a fugitive species, succeeding in early— to mid—successional vegetation, and relying on disturbance to open up new areas for colonization. The growth rate of a lousewort population depends largely on site characteristics, principally soil moisture and time since disturbance. Excluding effects of succession, populations on saturated soils grow most rapidly, those on moist soils grow moderately fast, and those on dry soils grow slowly or even decline (Gawler 1988). (USFWS, 1991; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds appear to be dispersed by wind and water (Waller et al. 1988).

***Population Information and Trends***

**Population Trends:**

Long-term trends suggest declines of 30 to 50%, whereas short-term trends indicate declines of 10 to 30% (NatureServe, 2015)

**Species Trends:**

Declining (NatureServe, 2015)

**Resiliency:**

Narrow endemic species with only two small populations and limited geographical ranges. Count data from surveys over almost two decades indicate both are declining 9-12% annually. Occupancy of shoals has declined in the Conasauga, and fish in both systems have been extirpated or greatly reduced in abundance in the lower reaches of the historic range. Resiliency = low to very low (USFWS, 2018).

**Representation:**

Two declining populations genetically-isolated by Lake Allatoona. Representation = Low to Moderate (USFWS, 2018).

**Redundancy:**

Only two populations are known historically, and neither appears resilient to stochastic or catastrophic events and/or to current anthropogenic stressors. Redundancy = low (USFWS, 2018).

**Number of Populations:**

20 subpopulations distributed across 140 river-miles (USFWS, 2019)

**Population Size:**

~2397 (USFWS, 2018)

**Adaptability:**

Low (inferred from USFWS, 1991)

**Additional Population-level Information:**

All subpopulations at or near lowest recorded numbers since 1980. Two subpopulations good condition, 2 subpopulations fair/good, 3 subpopulations fair, and 8 subpopulations poor condition. Six upriver subpopulations maintaining resiliency and redundancy. Fourteen downriver populations losing resiliency and redundancy; absent from 6 subpopulations. Largest contiguous habitats upriver; smallest, fragmented, eroded habitats downriver. One upriver subpopulation partially protected. One downriver subpopulation partially protected and one New Brunswick site protected. Habitat degradation (erosion, poor riparian buffer) greatest in downriver habitats. (USFWS, 2018)

**Population Narrative:**

Although Furbish's Lousewort is adapted to this highly dynamic riparian habitat, the species is vulnerable to high degrees of the annual ice scouring and flooding. Little genetic variability has been detected in this species. Populations of Furbish's Lousewort have declined since historic times. Long-term population trends suggest declines of 30 to 50%, whereas short-term trends indicate declines of 10 to 30%. The number of stems fluctuate widely with varying hydrological or environmental changes but in Maine have ranged from over 6000 plants to just over 2000 plants over a 25-year period. In New Brunswick the numbers of plants have ranged from 68 to over 1000 plants. Two element occurrences (one historic & one extant) are known in New Brunswick, whereas it is estimated that about three or four extant EOs occur in Maine. Lousewort populations are notoriously difficult to delineate, because the linearity and dynamism of the habitat dictate that populations are rarely discrete units. (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Alterations in hydrology (USFWS, 1991)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The cycle of intermittent disturbance by floods is crucial to the survival of the species. Damming free—flowing waters of the St. John would not only inundate some populations, but would affect all populations by preventing the ice scour and floods which now shape riverbank vegetation. New Brunswick Power is still pursuing possible modification of the existing dam at Grand Falls, New Brunswick as well as the creation of an additional hydropower facility near Morrill, New Brunswick. Potential and known populations in Canada and the United States from Madawaska to Hamlin would be eliminated by implementation of these projects. (USFWS, 1991)

**Stressor:** Land use (USFWS, 1991)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Aside from the continuing, albeit muffled, potential for dam construction on the St. John, widespread effects on lousewort populations resulting from changing land uses along the river as well as from increased river flows are the major concern at this time. changes in land use on the banks of the St. John River have occurred through the clearing of vegetation, especially trees, for individual houselots, views, and agricultural fields. The removal of trees to the river’s edge eliminates shade conducive to lousewort growth and reproduction, while the subdivision of the riverbank into residential and commercial building lots increases the difficulty of implementing conservation strategies. These land use practices within the St. John River

watershed appear to affect Furbish lousewort habitat and populations. (USFWS, 1991)

**Stressor:** Increased runoff (USFWS, 1991)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In addition, there is evidence that the spring flows of the St. John River have been increasing since the 1940's (Menges and Gawler 1986), possibly due to excess runoff. Increased runoff (Gawler and Menges 1984), perhaps caused by accelerated timber harvesting within the watershed, may exacerbate the disturbance impacts to lousewort habitat. For instance, deforested areas can reduce the water retention capability of the watershed; increased river flows and resultant bank slumping may then eliminate habitat and populations at an artificially high rate. (USFWS, 1991)

**Stressor:** Habitat alteration (USFWS, 1991)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** More localized activities such as direct habitat alteration and the burial of individual plants by the dumping of refuse and slash continue to be minor threats to particular lousewort populations. Causes of habitat degradation associated with shorefront developing include dumping of refuse, slash, and fill; motorized vehicles, vegetation clearing, ATV use along the river bank, personal boat access, and impermeable surfaces that focus runoff. (USFWS, 1991; USFWS, 2007)

**Stressor:** All-terrain vehicles (USFWS, 1991)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impacts from all—terrain vehicle traffic and bank use by recreationists may become threats as these activities increase in the area. (USFWS, 1991)

**Stressor:** Residential development (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The conversion of farms for residential development, which alters the riparian forest or riverbank vegetation, is an increasing conservation concern. (USFWS, 2007)

**Stressor:** Invasive species (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Competition for invasive species is a threat to the unique riverbank ecosystem in the lower river segments. Phragmites, Japanese knotweed, non-native grasses, and purple loosestrife have all been documented in lousewort habitat. These invasive plant species are linked to human activities such as riverbank clearing, trails, and mowing, and spread of invasive species is one consequence of shorefront development. (USFWS, 2007)

**Stressor:** Forest management (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Forest management in the watershed could increase siltation and run-off (Menges and Gawler 1986). (USFWS, 2007)

**Stressor:** Climate change (USFWS, 2007; USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is expected to affect the ice regime of northern rivers, including the St. John, by increasing the frequency of severe ice-scour events and patterns os spring ice breakup (Beltaos 1997, Beltaos and Prowse 2001). Beltaos (1999) did a hydroclimatic analysis for the upper St. John River using long-term climate and flow records and documented that a small rise in winter air temperatures over the past 80 years has already resulted in a substantial increase in the number of mild winter days and the amount of winter rainfall- previous rare occurrences in this region. These two factors have augmented river flows, causing increased breakup of ice cover and flow peaks in late winter and the frequency of spring ice jams and flooding. (USFWS, 2007); The Furbish's lousewort is identified as one of Maine's plant species most vulnerable to climate change (Jacobson et al. 2009, p. 33). The species depends on periodic disturbance of the riverbank from ice scour; not too frequent or too infrequent and not too severe (section 2.4). Climate change is expected to affect the ice regime of northern rivers, including the St. John, by increasing the frequency and severity of severe ice-scour and flood events (Beltaos 1997, entire; Beltaos and Prowse 2001, entire; Beltaos and Prowse 2009, entire). In summary, there is evidence suggesting that climate change is indirectly affecting the ice dynamics of the St. John River and these factors have the potential to increase the severity of the spring breakup and increased severity of flooding (Beltaos 2002, entire).We will evaluate climate change as a stressor further in our assessment of future scenarios. (USFWS, 2018)

**Stressor:** Increased frequency of ice jam events (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The increased frequency of ice jam events is a particular concern. The frequency of flooding events on the St. John River has increased since the 1940s (Menges and Gawler 1986). Lousewort biology suggests that a disturbance interval of less than 6 to 10 years would interfere with maturation and seed production (Menges 1990). (USFWS, 2007)

**Stressor:** Development (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes in land use on the banks of the St. John River in downriver areas have occurred through the clearing of vegetation, especially trees, for agriculture, individual house lots, roads, and river views. These land use changes within the St. John River valley may have negatively affected some of Furbish's lousewort subpopulations' habitat through removal or

reduction of the forested riparian buffer and subsequent loss of shade critical to lousewort growth and reproduction. Areas cleared of forest and impermeable surfaces associated with development have led to erosion and subsidence of the unconsolidated glacial till soils, and caused slumping and erosion of Furbish's lousewort habitat. We will evaluate development as a stressor further in our assessment of future scenarios. (USFWS, 2018)

***Recovery***

**Reclassification Criteria:**
In light of the recommendation to reclassify the Furbish's lousewort as threatened, downlisting criteria in the 1991 Recovery Plan (USFWS 1991) are now obsolete. (USFWS, 2019)

**Delisting Criteria:**
Criterion 1. The metapopulation is viable, comprising a 30-year median of 4,400 flowering stems or greater, and distributed as follows: Upriver: a 30-year median of2,800 flowering stems or greater in at least 6 subpopulations with at least 3 good and 3 fair subpopulations; Downriver: a 30-year median of 1,600 flowering stems or greater in at least 9 subpopulations with at least 3 good and 6 fair subpopulations. Once the upriver and downriver criteria are reached, the median number of flowering stems for each respective river section will remain stable or increase over a period of at least 30 years (three generations) without augmentation, reintroduction, or hand pollinating of plants. Additionally, in New Brunswick there is a 30-year median of 1,100 plants distributed among at least 5 subpopulations (Resiliency and Redundancy). (USFWS, 2019)

Criterion 2. There is long-term habitat protection for all subpopulations in Maine that provides for the species' needs throughout its life cycle. Long-term habitat protection mechanisms must assure important species' needs: forest overstory shade conditions (about SO-percent sunlight) by protecting or restoring a forested riparian buffer of 250 feet adjacent to suitable habitat; moist soil conditions and seeps by limiting further shoreline erosion and bank slumping, and restoring suitable habitat where it has been damaged from past events; native vegetation that newly germinated Furbish's lousewort plants can parasitize; site conditions without excessive plant competition, especially from tall shrubs and robust herbs; populations of the half-black bumble bee sufficient to assure pollination and subsequent seed production. (USFWS, 2019)

**Recovery Actions:**
- I. Monitor the Furbish's lousewort population and demographics and periodically assess the status of the bumble bee pollinator to document trends. (USFWS, 2019)
- 2. Improve the health and viability of extant subpopulations and restore extirpated subpopulations throughout the historical range. (USFWS, 2019)
- 3. Achieve long-term habitat protection for each subpopulation. (USFWS, 2019)
- 4. Conduct scientific investigations to improve understanding of stressors, viability, propagation, restoration, and genetic needs. (USFWS, 2019)
- 5. Periodically review progress toward achieving recovery criteria and employ strategic conservation and adaptive management to address threats. (USFWS, 2019)
- Contingency recovery strategies will be implemented if the metapopulation in Maine falls below 1,200 flowering stems OR if there are 4 or fewer upriver subpopulations OR if there are 2 or fewer downriver subpopulations OR if seed production is not sufficient to achieve a

stable or increasing metaoooulation. (USFWS, 2019)

- 6. Establish new subpopulations in unoccupied areas having suitable habitat. (USFWS, 2019)
- 7. Store seeds and establish captive populations. (USFWS, 2019)
- 8. Enhance seed production. (USFWS, 2019)
- 9. Work with Canadian partners to implement strategies that prevent extinction. (USFWS, 2019)
- To be considered for delisting in the near future, the Service needs specific information on: 1) the degree of threat from residential development in river segments 2, 3, and 4; 2) the degree of threat from climate change and severe ice jams and flooding; and 3) population viability in the context of a dynamic environment. (USFWS, 2007)
- New recovery criteria should be developed based on current information on population viability and responses to habitat perturbations, specifically related to improving municipal shoreland zoning, addressing habitat restoration caused by catastrophic ice scour events, and controlling invasive species. (USFWS, 2007)
- Efforts to protect lousewort habitat in the lower river reaches should be emphasized. (USFWS, 2007)

***Conservation Measures and Best Management Practices:***

- USFWS. 2019a. Furbish’s lousewort (Pedicularis furbishiae). 5-Year Review. U.S. Fish and Wildlife Service. Maine Field Office. East Orland, Maine. 6 pp.

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USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed July 2016

USFWS. 1991. Furbish Lousewort (Pedicularis furbishiae) Revised Recovery Plan. New England Field Office, Concord, New Hampshire. USFWS. 2023. FR Vol. 88, No. 90. Pages 30047-30057. Final Rule. Endangered and Threatened Wildlife and Plants

Reclassifying Furbish’s Lousewort (Pedicularis furbishiae) From Endangered to Threatened Status With a Section 4(d) Rule.

USFWS. 2018. Species status assessment for the Furbish’s lousewort (Pedicularis furbishiae).Version 1.1. Maine Field Office, East Orland, Maine. 59 pages + 3 appendices.

USFWS. 1991. Furbish Lousewort (Pedicularis furbishiae) Revised Recovery Plan. New England Field Office, Concord, New Hampshire

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U.S. Fish and Wildlife Service. 2018. Species status assessment for the Furbish’s lousewort (Pedicularis furbishiae).Version 1.1. Maine Field Office, East Orland, Maine. 59 pages + 3 appendices.

USFWS. 2007. Furbish's lousewort (Pedicularis furbishieae) Five-Year Review: Summary and Evaluation. Maine Field Office, Old Town, Maine

USFWS. 2019. Recovery plan for the Furbish's lousewort (Pedicularis furbishiae). Second Revision. September, 2019. U.S. Fish and Wildlife Service, North Atlantic - Appalachian Region, Hadley, Massachusetts. 14 pages.

Recommendations for Future Actions: Continue to monitor the subpopulations of the species and document population trends. Maintain current long-term habitat protections for subpopulations in Maine. Work with Maine landowners and municipalities to develop conservation easements or fee title opportunities to protect additional subpopulations. Continue to evaluate the effects of climate change and development. (USFWS, 2019)

# SPECIES ACCOUNT: *Pediocactus despainii* (San Rafael cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/16/1987; Mountain-Prairie Region (R6) (USFWS, 2016)

**Physical Description**

A small, spiny succulent. Stems can swell to up to 6 dm in height, but during dry or cold weather the plants may not appear above ground at all; the species is easily overlooked except in the spring, when bronze-tinted, yellow to peach-colored flowers are in bloom (NatureServe, 2015).

**Taxonomy**

The plant genus Pediocactus contains nine species (eFloras 2014). Winkler cactus and San Rafael cactus are very closely related with a blending of morphological characteristics where their ranges meet (Porter et al. 1999) (USFWS, 2015).

**Historical Range**

Endemic to south central Utah (USFWS, 2015).

**Current Range**

San Rafael cactus is found exclusively in Emery County, Utah. Overall, the known San Rafael cactus populations are found from Dripping Spring in the north, to Big Ridge South/Keesle Country to the south (approximately 122 km (78.5 mi) north to south), and from Mussentuchit Mine in the west, near the border of Sevier to the Humbug population in the east (approximately 88 km (48.5 mi) east-west) (USFWS, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual: cross-pollination (USFWS, 2015)

**Lifespan**

Adult: 20+ years (USFWS, 2015)

**Breeding Season**

Adult: March - May (USFWS, 2015)

**Key Resources Needed for Breeding**

Adult: Bee pollinators (USFWS, 2015)

**Reproduction Narrative**

Adult: It is reported to have low fruit/seed output (USFWS 2007; NatureServe, 2015). Some monitored cacti lived at least 20 years after tagging, although the age of the cacti at the time of tagging was unknown (Clark et al. 2015). The species reproduces sexually, is self-incompatible; cross pollination is needed to produce viable seeds (Tepedino 2000). Pollinators visiting San Rafael cactus include many species of bees, from multiple families. Flowering occurs from March to May with fruiting from May to June (Heil 1984) (USFWS, 2015).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Semi-arid grassland, desert pavements in pinyon-juniper woodlands (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 4,760-6,820 ft. elevation (USFWS, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: Inhabits desert pavements of cobble or pebble in pinyon-juniper woodlands (Flora of North America Editorial Committee 2003). Hills, benches and flats, of open, semi-arid grassland with scattered junipers and pinyon pines. (NatureServe, 2015). San Rafael cactus grows in a wide variety of soils, although it may favor fine textured mildly alkaline soils rich in calcium and derived from limestone substrates of the Carmel Formation and the Sinbad member of the Moenkopi formation. It has also been found on shale barrens of the Brushy Basin member of the Morrison, Carmel, Mancos and Dakota geologic formations and in areas of primarily alluvial and colluvium soils. It is found hill tops, and gentle slopes, and most abundantly on sites with a south exposure at elevations of 1450-2080 m (4760-6820 ft.). San Rafael cactus requires intact habitats relatively free of invasive species. This species also requires the presence of native plants which support their pollinators in order to successfully reproduction (USFWS, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Members of Pediocactus produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced in June, to fall (NatureServe, 2015).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

10 - 30% decline (NatureServe, 2015)

**Number of Populations:**

29 (USFWS, 2024)

**Population Size:**
21,555 (USFWS, 2024)

**Minimum Viable Population Size:**
Unknown; probably 500 individuals per population (USFWS, 2015)

**Adaptability:**
Low (inferred from NatureServe, 2015)

**Population Narrative:**
Little variation exists within populations. The fragile habitat makes the species vulnerable to disturbances. USFWS 2007). The short term population trend is decreasing (10 - 30%) (Butterworth and Porter 2013) (NatureServe, 2015). There are 20 populations of San Rafael cactus, with a total of approximately 8,200 documented individuals (BLM 2012, 2012a, 2013a; Truman 2014, 2015). Based on the most recent survey data, the estimated area of the known populations is approximately 152,971 ha (378,000 ac) (USFWS 2014). The minimum viable population size for this cacti species is unknown. It is likely that population sizes of at least 500 individuals per population are necessary to avoid extirpation (USFWS, 2015). For San Rafael cactus, we recognize has 29 populations with 21,555 plants, including the Blue Bench population that was previously categorized as Winkler cactus (Wang 2018). We used the same three population size categories as Winkler cactus and consider there to be five large populations, 3 medium populations, and 21 small populations (Service 2024). The total population count is much larger than reported in the 2016 draft recovery plan (8,553 plants) because of an expanded survey effort by the BLM and the addition of the Blue Bench population in Sevier County (Service 2024). As with Winkler cactus, known population counts should be considered conservative numbers erring on the low side of actual plant abundance since seedlings and dormant plants are difficult or impossible to detect. It is also difficult to know in any given year whether a plant is dormant or dead (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Recreation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The majority of the known San Rafael cactus individuals occur near established unpaved roads and are subject to dust effects. Pressures from recreation, including OHV use and biking are extremely high at the two largest known San Rafael cactus populations. All recorded individuals of San Rafael cactus occur on BLM (85 percent) or SITLA (15 percent) land that is open to OHV use on designated routes only. Two heavily used, unofficial OHV recreational areas are located adjacent to or within occupied habitat areas and are impacting individual plants and their habitat. In addition to OHV use, other forms of recreation, including camping and bike riding, exert pressure on some San Rafael cactus populations, particularly the Wedge and Millsite populations (USFWS, 2015).

**Stressor:** Livestock disturbance (USFWS, 2015)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Trampling by livestock has been recognized as a threat to San Rafael cactus since at least 1981, with impacts to cacti documented regularly since that time (Heil et al. 1981; Spector 2013). Grazing is permitted throughout the known range of San Rafael cactus and evidence of livestock has been recorded in every population, although grazing pressure is not equal at every population or every surveyed site within a population. San Rafael cactus occurs on 19 grazing allotments managed by the BLM Price Field office (USFWS, 2015).

**Stressor:** Ungulate disturbance (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Deer prints have been documented within 15 cm (5.9 in) of San Rafael cactus at several sites and can locally be more abundant than livestock tracks but are not as widespread (Spector 2013). For example, in the Millsite/Clawson population, deer disturbance within 15 cm (5.9 in) was found in places at rates over 20 percent, including one survey site with a rate of 95% (BLM 2012); the survey sites are located near an area called Diversion Hollow (BLM 2012; Truman 2014). Deer winter in the area and spring use is high in some parts of the Millsite/Clawson population area. Impacts and disturbance to plants and habitat from wild horses and burros can be very similar to those of cattle and other livestock grazing. Wild horses and burros occur within a portion of San Rafael cactus range in the BLM Price Field Office planning area (BLM 2008a). (USFWS, 2015).

**Stressor:** Energy and mineral exploration and development (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Approximately 86 percent of the total population San Rafael cactus occurs on BLM land that is open to oil and gas leasing either with no additional constraints or subject to minor constraints, including the entirety of the two largest populations (The Wedge and Millsite/Clawson). Previous energy development activity in the Millsite area has destroyed individual plants and occupied habitat (BLM 2008a; Clark 2011). There is a high level of interest in development throughout the range and the majority of the species' occupied habitat is open to leasing. The negative impacts on cactus habitat from oil, gas, and mining development, are well documented (USFWS, 2015).

**Stressor:** Paleontological exploration (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** San Rafael cactus may be subject to some impacts from paleontological exploration and excavation. Emery County is the location of a number of paleontological sites, including the Cleveland-Lloyd Dinosaur Quarry near Price. Paleontological interest in the area has been increasing with recent finds on BLM land (Truman 2014). Disturbance to plants from paleontological activities can include direct injury or mortality of plants situated at an excavation site, effects from dust due to surface disturbance at excavation sites, and impacts from associated activities such as camping near and hiking into sites by paleontological field crews

(USFWS, 2015).

**Stressor:** Invasive plants (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Non-native invasive species are known throughout the ranges of San Rafael cactus, the most common of which are cheatgrass (Bromus tectorum), halogeton (Halogeton glomeratus), and Russian thistle (Salsola tragus). San Rafael cactus inhabits sparsely vegetated areas that are not prone to fire, but the presence of invasive plants can alter local fire regimes (Stoddart et al. 1951; Harper et al. 1996; Brooks and Pyke 2001; Brooks et al. 2003; Duda et al. 2003). Cacti are not adapted to frequent fires in their habitats and are therefore not expected to persist through more frequent and intense fire cycles. In addition, fires may produce intense heat that can kill seeds, thereby reducing seedbank viability (Brooks and Pyke 2001) (USFWS, 2015).

**Stressor:** Collection (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is highly desired in cactus collections and gardens and are sought by hobby and commercial cactus collectors (Hochstatter 1990; Heil 1984). The fact that this species is difficult to maintain in garden settings stimulates a continual demand for replacement plants as cultivated garden and greenhouse plants die. Cactus collectors are active in the Colorado Plateau, going from the habitat of one species of Pediocactus to the next to collect a complete set of the genus (Heil 1994; 52 FR 32914, September 16, 1987; 63 FR 44587, August 20, 1998) (USFWS, 2015).

**Stressor:** Predation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species is susceptible to infestations and mortality of insect larvae, including the flightless cactus borer beetle (Moneilema semipunctatum). The cactus borer beetle larvae enter the plant by eating tunnels, usually at ground level in the stem of the plant and ultimately ingest most of the plant stems’ succulent cortex. Cactus-borer beetle predation can result in 25 to 30 percent mortality in cacti populations, and episodic die offs of significant portions of this species populations due to cactus borer beetles were observed within the past 25 years (Kass 1990; Neese 1987; USFWS 1995; 52 FR 32914, September 16, 1987; 63 FR 44587, August 20, 1998). San Rafael cactus is also predated by weevils. At the Wedge population, 3 percent were found to be infested with weevils which consume the flower buds thereby preventing reproduction. An additional 5 percent were noted to have damage from an unidentified rodent or insect, and several were observed to be infested with the cactus borer beetle (Robinson 2011) (USFWS, 2015).

**Stressor:** Small population size (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Of the known populations of San Rafael cactus, more than half consist of less than 100 recorded individuals and all but three consist of less than 500 individuals (even if the five populations in the McKay flats allotment were shown to be connected, that population would still consist of less than 500 individuals based on current data). This means a majority of populations of this species are moderately to extremely vulnerable to extirpation from known threats and stochastic events. Very little data on genetic diversity within this species exists, and none at all for many of these populations. The loss of any one population could constitute a major loss of genetic diversity for the species (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** climate change and its impacts to the region are well documented and projected to continue and increase. There was a documented decline of Winkler cactus during the 1999-2003 drought, and the similarity of San Rafael to Winkler cactus suggests a comparable response. (Clark and Clark 2008). Additionally, rare plants have a negative response to drought (Roth 2003, 2004; Van Buren and Harper 2003, 2004), and drought severity and frequency is set to increase due to climate change (IPCC 2007; Karl et al. 2009) (USFWS, 2015).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 11

**Delisting Criteria:**
1. Based on analysis and modeling implemented under the recovery actions, trends for San Rafael cactus populations are shown to be stable or improving according to the following measures: a) Species presence is maintained at all known San Rafael cactus populations; and b) Within at least three-quarters of the known populations that represent the majority of the total known individuals (and including the Wedge, Millsite/Clawson, and all of the McKay Flats populations) and represent the range of geographical, morphological, and genetic diversity of San Rafael cactus, plant density within occupied habitat is stable or improving over a 20-year period. These populations would be designated as Recovery Populations and this measurement would be based on a standardized, long term monitoring protocol developed by the Recovery Team and managing agencies; and c) Predictive modeling using data from an additional 10-year period (30 years total), collected in accordance with a standardized monitoring protocol, provides an indication of long-term demographic stability as well as a projected survival probability of at least 95 percent over 100 years for the species (USFWS, 2015).

2. Based on best available data, the available habitat base for each recovery population of the species is of sufficient quality and large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and, where possible, among populations (USFWS, 2015).

3. Population and habitat management is implemented for all populations of the species in accordance with management plans developed under Recovery Action 1 (Section 3.4). The management plan will include a course of action that addresses the following needs: habitat protection and management, threats abatement, biological and threats monitoring, and reporting and evaluation (USFWS, 2015).

4. Federal land protection through long-term management agreements or plans is achieved for all known San Rafael cactus populations. Protection considerations from grazing impacts, development, mining, oil and gas, and recreation must be included in the management agreements and the protected areas must meet the size and connectivity parameters determined through research to be adequate to sustain those populations. These may include but are not limited to resource management plans, conservation agreements, recreation management plans, and travel management plans (USFWS, 2015).

5. Management agreements or plans in place and being implemented for all San Rafael cactus populations on all federal lands must include measures to address and curtail illegal collection activities. These plans should include criteria for appropriate law enforcement at correct times and places to prevent illegal collection and sales of plants or any plant parts (USFWS, 2015).

6. Adverse population-level effects from herbivory, disease, or predation, if any, are identified, monitored and abated to the extent that at least three quarters of known San Rafael cactus population trends are stable or increasing, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under Recovery Action 2.4 (Section 3.4). Programs to control excessive herbivory or predation will be developed to adaptively manage each population per criterion P-3, and must take into consideration the degree which climate change may impact disease or herbivory levels in the future (USFWS, 2015).

7. Land protection covering the habitat of all populations for the species and/or statutory and regulatory protections for plants are such that the protections of the ESA are no longer needed to compensate for regulatory inadequacies (USFWS, 2015).

8. A long-term ex-situ conservation program is ongoing for all extant San Rafael cactus populations. This would include seed collection and storage, germination and viability trials, and development of a protocol for successful reproduction under greenhouse conditions. This would help avert the risk of extinction from stochastic events or environmental catastrophes (USFWS, 2015).

9. In conjunction with recovery criterion P-2 (criterion 2), the available habitat base for each of the populations designated under criterion P-1 (criterion 1) is of sufficient quality and large enough to offset the threat of loss or restriction of the species’ pollinators. Effective measurement criteria will be developed through research under Recovery Action 3 (USFWS, 2015).

**Recovery Actions:**

- Protect and conserve known extant Winkler cactus and San Rafael cactus populations and their habitat (USFWS, 2015).

- Survey for additional populations, and monitor all populations in order to apply conservation measures where and when needed (USFWS, 2015).
- Conduct in depth research into the biology, requirements, threat responses, and life histories of both species in order to develop and implement appropriate management practices for the purposes of achieving recovery (USFWS, 2015).
- Promote communication by encouraging and creating dialog regarding these species between managing agencies, land owners, developers, and the public in order to raise awareness and aid recovery (USFWS, 2015).
- Coordinate and work together with all stakeholders to achieve recovery (USFWS, 2015).
- Survey and repeat inventory efforts were completed throughout the range of the species beginning in 1987. These were a responsibility of the Interagency team from 1998 through 2008, which then transferred to individual managing agencies from 2011-2013. Because of these efforts, there is a better understanding of the status and distribution of the species as well as habitat requirements. Although many more occupied sites and populations are now known than at the time of listing, not all suitable habitat has been surveyed. There is currently no comprehensive, funded plan from any of the managing agencies for continued inventory and monitoring of the species (USFWS, 2015).
- A habitat modelling project for the species has been initiated by the USGS, with funding from USFWS and the support of the BLM and CRNP, which will use existing inventory and site data to help determine potential suitable habitat and delineate the range of San Rafael cactus. The model will identify the most influential environmental factors of presence/absence for the species. This will be useful in locating additional sites and populations, as well as helping determine the need for cactus surveys prior to proposed projects that impact potential habitat (USFWS, 2015).
- Seeds of San Rafael cactus have been collected for conservation purposes, most recently in 2013. Seeds are currently stored and maintained at the National Center for Genetic Resource Preservation in Ft. Collins, CO and at Red Butte Garden in Utah. No plants are currently being propagated (USFWS, 2015).

***Conservation Measures and Best Management Practices:***

- Recommended future actions: We recommend rangewide surveys of known populations for Winkler cactus and San Rafael cactus, and that survey results be used to compile a robust, updated population estimate. Additional research that provides a better understanding of current population demographics, population trends, and the impact of and response to the primary threats is vital to evaluating these species' status in the future and to developing updated and meaningful recovery criteria and actions. The designation and management of protected areas that reduce impacts from identified threats may be necessary to facilitate this species' recovery. Additionally, we recommend updating and finalizing the draft recovery plan and specifically reevaluating the recovery goals and criteria based on new population numbers, habitat requirements, connectivity analysis, and recent and upcoming changes in management and conditions that may result in changes to threat intensity and scope (USFWS, 2019)

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# SPECIES ACCOUNT: *Penstemon haydenii* (Blowout penstemon)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/01/1987; Mountain-Prairie Region (R6) (USFWS, 2016)

**Physical Description**

The blowout penstemon (Penstemon haydenii), a member of the snapdragon family, is a hairless perennial that grows 1 to 2 feet high. The stems are often decumbent, simple, or branched, and very leafy. The stem leaves are linear to lanceolate, entire, 3 to 5 inches long by 1 to 3 inches wide, sessile and clasping. The inflorescence is a compactly crowded thyrse. A thyrse is composed of (1) a main axis of an inflorescence made up of flowers born on stalks of about equal length along an elongated axis that continues to grow during flowering and open in succession from below and (2) secondary and later axes of the inflorescence that terminate in single flowers. Floral bracts are ovate to lanceolate, nearly equaling the flowers. The corolla is milky blue to pale lavender (rarely pink or white) and 1.5 to 2 inches long. The sterile staminode is glabrous and/or hairy. Fruits are 0.5 to 0.6 inch long capsules, acute, with light brown, disc-shaped seeds having winged margins (Heidel 2005, USFWS 1987).

**Current Range**

Blowout penstemon is a regional endemic of the Nebraska Sandhills, the largest sand dune system in North America, located in north central Nebraska (Stokes and Swinehart 1997, Forman et. al 2001). The Nebraska Sandhills is an area of stabilized sand dunes covering 5 million hectares (approximately 12.4 million acres). In 2008, 32 blowout penstemon subpopulations (10 native and 22 introduced) were known to occur in the Sandhills (Stubbendieck 2008). In Wyoming, 3 populations (in addition to 6 subpopulations) of blowout penstemon are located in the Ferris Dunes of northwestern Carbon County, separated from the Nebraska Sandhills by about 175 miles (282 km). The Ferris Dunes cover an area less than 124,000 hectares (50,000 acres). See Figure 1 Geography below.

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: flowers from mid-May to late June in Nebraska

**Reproduction Narrative**

Adult: The species flowers from mid-May to late June in Nebraska. The flowers have a strong, persistent fragrance that lures several kinds of bees and other pollinators. The fruit (capsule) matures and splits in early to mid-August and the seeds either fall near the base of the plant or are transported primarily by wind to other areas within the blowout or outside of the blowout. All healthy flowering plants are thought to produce seed (USFWS 1992). Most blowout penstemon plants begin to bloom at 2 to 3 years of age (Stubbendieck et al. 1993) and have been successfully cultivated in the greenhouse (Flessner and Stubbendieck 1989, 1992).

Flowering in Wyoming occurs later than in Nebraska (late June to early July), probably in response to drier and cooler climatic conditions (Fertig 2001). Each fruit of the blowout penstemon contains an average of 25-35 seeds with as many as 1500 seeds per plant. The seeds are winged presumably to aid in wind dispersal although, given the high degree of herbivory of this plant, some questions have been raised that animals might also be an important avenue of seed dispersal (Heidel 2005). Seeds are released from late August through September. The seeds, potentially remaining dormant in the sand for 20 years, have a thick outer coat and germination is enhanced after some degree of scarification. Axillary root branching may be an adaptation to survive burial by wind-blown sand rather than a common form of reproduction. By digging around individual blowout penstemon plants, Heidel (2005, 2012) did not find evidence of long-distance underground connectivity between adjacent plants.

**Habitat Type**

Adult: Sand dunes

**Environmental Specificity**

Adult: Very Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Characterized as a "primary" blowout species (Pool 1914) on active sand dunes in Nebraska sandhills prairie (Stubbendieck et al. 1989, Kuchler 1964). The term 'blowout' refers to a naturally occurring depression in the Nebraska Sandhills. These depressions are caused when vegetation at the upper slope of a hill is disturbed, typically by fire or grazing animals. The 'blowout' may take as many as ten years to be come a full scale and active blow out. The process is started when sand is deposited from the windward side of the slope to the leeward side, and this process continues until eventually the roots of the surrounding vegetation are exposed and finally ripped up by the force of the wind. Eventually, a crater is created where there is constant wind action, so succession is continually taking place (Stubbendieck et al. 1989). For a detailed description of blowout ecology, see Stubbendieck et al. (1989). Penstemon haydenii occurs within the blowout usually near the leeward side only after the sand has stabilized, and it declines once vegetation is established.All sites have less than 10% basal ground cover (Heidel 1981). Initial colonization of dunes is by Redfieldia flexuosa. Psoralea lanceolata is locally common where P. haydenii is found (Heidel 1981). Other common associates include: Andropogon hallii, Artemisia campestris, Asclepias arenaria, Astragalus longifolia, Calomovilfa longifolia, Cirsium plattensis, Helianthis spp., Hymenopappus corymbosus, Lathyrus polymorphus, Linum sulcatum, Lithospermum incisum, Lygodesmia rostrata, Oenothera serrulata, Oryzopsis hymenoides, Petalostemum villosum, Rume venosus, Tradescantia occidentalis, and Yucca glauca (Heidel 1981; Lichvar 1982). (NatureServe, 2015). Blowout penstemon was first collected along the North Loup River in the Sandhills area of Nebraska by Ferdinand V. Hayden, probably in 1857 (Sutherland 1988). This specimen was without flowers or fruits and was referred to as sharp leaf penstemon, Penstemon acuminatus. Senero Watson originally named and described the species as Penstemon haydeni, based on a collection made by H. L. Webber near the Dismal River in Thomas County, Nebraska in 1891 (Watson 1891). Later, Francis W. Pennell could not locate the original 1857 Hayden specimen, and he substituted the Webber specimen as the type collection (Pennell 1920). Both the Hayden specimen and type specimen were deposited at the Gray Herbarium at Harvard. A second "i" was later added to the specific epithet "haydeni" to make it etymologically correct (Sutherland 1988). The most recent morphological descriptions report a deep taproot and stems which root adventitiously in shifting sand (Great Plains Flora Association 1991). No other populations of blowout penstemon were known outside of Nebraska until 1996. In 1996, the Bureau of Land Management (Frank Blomquist) discovered a small colony of blowout penstemon south of the Ferris Dunes (Fertig 1999). Plant samples were later collected and verified by Dr. Noel Holmgren of the New York Botanical Gardens for verification in 1999. Field identification was subsequently confirmed by additional specimens sent to Dr. James Stubbendieck of the University of Nebraska and Dr. Holmgren. There has been some reason to question whether the populations in Wyoming and Nebraska should be considered members of the same species. Blowout penstemon individuals in Wyoming have divergent flower traits that had not been previously reported (Heidel 2007). At the time of the Five year review, there were still questions as to whether the morphological differences between the Nebraska and Wyoming populations are due to phenotypic plasticity, genetic differences, or a combination of these factors affecting populations. Further consultation with taxonomic experts is ongoing. All known blowout penstemon sites are well-developed blowouts in dune complexes with active sand and accompanying environmental extremes in wind, temperature, evapotranspiration, and soil moisture stress. Blowout penstemon plants are most frequently in microsites that are, or recently have been, zones of sand accumulation. The plant apparently is successional and is a pioneer species that does not persist when a blowout becomes completely vegetated. The species survives burial in sand by sending off shoots at successively higher nodes. It withstands initial erosion and has a rhizomatous system with extensive lateral roots to survive erosion that may uncover much of its root length (USFWS 1987).

***Dispersal/Migration***

***Population Information and Trends***

**Population Narrative:**

Blowout penstemon is a short-lived perennial plant, which requires actively moving sand in blowouts to thrive. It grows from a tap root, initially producing a single stem that often becomes decumbent. The stem roots readily where nodes are buried in the sand. Buds located at the base of the stem break dormancy in the second spring, often producing multi-stemmed plants. These plants typically flower in the second or third year (Kottas 2009), and individual plants live for six to eight years (Stubbendieck et al. 1997). The lavender (or occasionally blue or white) flowers produce two-sided capsules (ovaries) bearing 14 to 35 discoid brown to black seeds (USFWS 1992; Kottas 2009). Seeds have a thick, hard seed coat and germination in the field is typically very low. The seeds are adapted to dispersal by wind, which often distributes seed downwind across the edge of the blowout into the area of sand accumulation. Wind and animals aid in the seed dispersal (Stubbendieck, pers. comm. 2009). Seed numbers are highly variable among years and sites (Kottas 2009). Individual plants may produce approximately 1,400 to 1,500 seeds (Kottas 2009; USFWS 1992), but seed viability can reduce reproductive potential to an average of approximately 530 viable seeds per plant (Kottas 2008). The number of seeds in the seedbank is typically low, due mainly to predation by small mammals at the time of seed rain (Kottas 2009; Stubbendieck, pers. comm. 2009). Kottas (2009) investigated the effects of floral herbivory by insects and fungal infection on seed production and viability. She reported that treatments of plants with insecticide or fungicide did not significantly affect total seed output, weight or viability (Kottas 2009). Consequently, site specific herbivore, granivore and fungal impacts may be important when seed production is low or when the surrounding vegetation invades blowout penstemon habitat, bringing additional herbivory with it (Kottas

2009). The genus Penstemon is endemic to North America. Of 275 species in the Penstemon genus, only the blowout penstemon and one other species are fragrant (Kottas 2009). The common name of the blowout penstemon comes from the blowouts in the Sandhills of Nebraska. Blowouts are round or conical eroded areas, depressions formed in the sand when prevailing northwesterly winds scoop out the sides of the hills (Pool 1914 in Kottas 2009). These eroded areas form on the sides of dunes when vegetative cover is removed or disturbed and wind action further exposes the slopes (Stubbendieck et al. 1989). Blowout penstemon is a pioneer species in these blowouts, frequently found among blowout grass (Redfieldia flexuosa) which is often the first pioneer in a blowout (Kottas 2009). Neither blowout grass nor blowout penstemon persists after other grasses begin to invade the blowout. The amount of suitable, active blowout habitat has declined markedly since settlement of the Sandhills region in the early 20th century (USFWS 2012). In Wyoming, blowout penstemon is found primarily on the rim and lee slopes of blowouts, or the rim and steep faces of sandy slough slopes. These deposits are found at the base of mountains or ridges, which represent topographic barriers. Shifting sand dunes are prevented from becoming fully stabilized and overgrown because of wind and gravity. The dunes may be 60 to 120 feet high at elevations between 5860-7440 feet (Heidel et.al 2007). The blowout penstemon is found in the early stages of plant community development which can be composed of blowout grass, lemon scurfpea, and thickspike wheatgrass or Indian ricegrass (Heidel 2005). The Wyoming sites differ from Nebraska Sandhills in that the populations occur at higher elevations, the mean annual precipitation is lower, and Wyoming has cooler minimum and maximum summer temperatures.

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing in 1987, the species was known to exist in only six population centers in four counties of the Nebraska Sandhills. Approximately 7000 plants occurred on less than 10 hectares (25 acres). Improved range management practices and fire suppression which promote blowout healing, were a major cause of the species decline in Nebraska and that remains a major threat today. Given the nature of the different habitats occupied by blowout penstemon plants in Nebraska as compared to those in Wyoming, the degree of threat to populations in these two states may differ. When the blowout penstemon was listed as endangered under the Act, only the Nebraska populations were known, therefore only the threats to populations in Nebraska were considered. In Nebraska, despite conservation strategies to increase numbers of plants and populations within the range, two main areas hamper recovery: 1) Continual loss of blowout habitat due to the stabilization of sand dunes (and lack of habitat management) 2) Lack of plans to guide habitat management and a way to include written agreements to implement such habitat management into conservation plans that could protect the species where it primarily occurs (private land). Additional threats identified and discussed in the 5 year review include: drought, overgrazing, ORV use, construction practices, pesticides, and natural outbreaks of the pyralid moth. In Wyoming, populations have basically been preserved in more or less a natural state because of the isolated, currently inaccessible nature of the sites. However, there is potential moderate to significant impacts from future energy development to the species. As with other forms of development, wind energy facilities, have the potential to affect the natural dynamics of a dune system by directly or

indirectly causing changes to the erosion and deposition of sand. Blowout penstemon may be negatively impacted by changes in the dynamics of the dune system (i.e. loss of key habitat attributes, competition, etc.).

**Stressor:** Mining
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sand mining is currently not occurring in close proximity to any blowout penstemon sites, however more accessible sand deposits in the Rawlins Resource Area are currently being mined. The sand mined from those locations is used for golf courses and road maintenance. Presently, it seems impractical for sand mining to occur near blowout penstemon sites because of their relative isolation, rugged terrain, and limited access. Blowout penstemon populations in Wyoming are located over 7 miles from primary unpaved county roads to the north and east, and at least 15 miles from primary county roads to the west. Future changes in the accessibility to these habitats could affect the profitability and establishment of sand mines near blowout penstemon sites. Other valuable minerals located near the Seminoe Mountains to the south of the blowout penstemon populations include iron, copper, and gold (from Hausel 1989, in Heidel 2012).

**Stressor:** • Water Development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Near blowout penstemon habitat at Bradley Peak, Bear Mountain, and Junk Hill in Wyoming are excavated ponds, as well as natural ponds and springs used for sources of livestock water. It would not be feasible to develop these water sources as irrigation water for cultivated fields or central pivot irrigation as is done in Nebraska. Nevertheless, further livestock water sources developed near blowout penstemon populations could potentially concentrate livestock near these habitats causing increased grazing or trampling effects to the plants (Heidel 2005).

**Stressor:** • Oil and Gas Leasing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oil and gas leasing occurs at the west end of the Bear – Mountain – Junk Hill – Ferris blowout penstemon population. This development includes pumps, pumping stations, and a pipeline corridor (Heidel 2012).

**Stressor:** • Off-Highway Vehicle Use
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-highway vehicle (OHV) use has been observed within a blowout penstemon population in Nebraska, and many plants were damaged (USFWS 1992). Hill climbing and associated OHV recreation activities may ensure continued disturbance and erosion of the sand hills and dunes, but driving over and crushing plants may cause severe negative impacts to the plants (USFWS 1992).

**Stressor:** • Changes in Habitat Quality
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, fires removed the protective cover from the soil in the Nebraska Sandhills region resulting in shifting sand dunes and blowouts. Control of prairie fires followed the area's settlement period. Virtual elimination of fire from the Sandhills ecosystem allowed the vegetation to advance into the majority of the eroded areas and to stabilize the sand, resulting in a decline in suitable habitat for the species (USFWS 1992). However, continual summer grazing by cattle during the first half of this century caused enough disturbances to maintain many blowouts. More recently however, the increased use of planned grazing systems (rotational grazing) during the past 30 years has greatly reduced disturbance and has been responsible for decreasing wind erosion. Other advanced range management practices in Nebraska, including techniques to more evenly distribute livestock on rangeland, have been responsible for decreasing blowout penstemon habitat, as well as the numbers of populations, and the numbers of individual plants (USFWS 1992).

**Stressor:** • Livestock Trampling and Grazing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Sheep previously grazed the allotments occupied by blowout penstemon in Wyoming. Cattle and horses are now commonly found on the rangelands of both Nebraska and Wyoming. The influence of horses on blowout penstemon has not been documented. Cattle, however, have frequently been observed near blowout penstemon plants. Many individual plants have been inspected during and after cattle grazing periods. When adequate other forage is available, cattle occasionally graze a portion of a plant but seldom does this cause major damage to the plant (BLM 2012, USFWS 1992). Under these normal range conditions, the use of high livestock stocking rates as a disturbance factor to maintain habitat for the blowout penstemon is considered beneficial (USFWS 1992). Advanced grazing methods, referred to as "holistic resource management", may further decrease blowout penstemon habitat by reducing active erosion. Techniques which more evenly distribute livestock on rangelands such as "planned grazing systems" or "management intensive grazing" may have been responsible for decreasing blowout penstemon habitat, numbers of populations, and numbers of individual plants in Nebraska (USFWS 1992). The occasional removal of a terminal portion of a shoot of a blowout penstemon plant by a grazing herbivore may be desirable because growth of other shoots is stimulated (USFWS 1992). However, during years of low precipitation, livestock forage may be limited and blowout penstemon plants may be more intensively grazed during those times. In Nebraska during times of limited forage availability, cattle have been observed to closely graze nearly every available blowout penstemon plant. One occurrence of close grazing by cattle may or may not impact blowout penstemon plants, but repeated years of close grazing will severely weaken plants and may be the direct cause of plant death (USFWS 1992) or reduce population numbers. o Cattle trampling of established plants has not been observed to be a problem. Infrequently, cattle will break a blowout penstemon shoot, which poses no threat to the plant (USFWS 1992). Livestock trampling damage is typically not significant to blowout penstemon plants because the plants are sparsely distributed in shifting substrate areas which cattle do not normally frequent. For Wyoming populations, it has been hypothesized that wildlife are the

primary source of blowout penstemon herbivory. Wild ungulates, such as deer and elk, may have a larger grazing impact on blowout penstemon plants than cattle in Wyoming. Fertig (2001) observed stem damage from deer and elk trampling on 10 percent of the population at Bear Mountain and on 60 to 80 percent of the stems at Bradley Peak. The tracks of elk and pronghorn antelope were repeatedly observed near browsed plants during survey efforts in Wyoming (Heidel 2005).

**Stressor:** • Over-collection
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The blowout penstemon is attractive and has been cultivated. Horticultural collecting is a potential threat for this species (USFWS 1987). To date, private and commercial collectors have had little impact on blowout penstemon. It would be an attractive and desirable landscape plant, but most of the plants are in locations which are too remote or inaccessible (USFWS 1992).

**Stressor:** • Pesticide Use
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The direct impact of herbicides on blowout penstemon is not known, although it is highly probable that broadleaf weed killers would negatively influence this plant (USFWS 1992). Herbicide use is thought to be minimally used on sand hills/dune regions due to the sparse cover of its habitat. It is doubtful that ranchers would even inadvertently apply herbicide to blowout penstemon, because most ranchers try to encourage the growth of all vegetation in blowouts. Use of insecticides could negatively impact the pollinators of blowout penstemon. Numerous types of insects may be responsible for pollination; however, it is unlikely that localized insecticide use would completely eliminate insect pollination (Heidel 2005).

**Stressor:** • Encroachment by other plants
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Non-native species in or adjoining blowout penstemon habitat in Wyoming included cheatgrass (Bromus tectorum) and Russian knapweed (Centaurea repens). Russian knapweed (C. repens) recently got introduced at the base of the Bradley Peak population site and could become a major infestation, possibly entering blowout penstemon habitat. Cheatgrass (B. tectorum) is one of the more common non-native species in the Pathfinder population and has been observed to be spreading in some of the Bear Mountain subpopulations (Heidel 2012). Weeds pose may pose threats as competitors. Any herbicides used to control the noxious weeds may pose a threat to the blowout penstemon.

**Stressor:** • Construction Activities
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The area between the Ferris and Seminoe Mountains is an area of particularly high mean turbulent kinetic energy, responsible for sand deposition on steep slip-face slopes

hundreds of feet high. In recent years, there have been wind energy permit applications that encompass blowout penstemon populations. Any alteration of on-site or upwind flow patterns, or related access development and construction, could affect the species and its habitat. There are four separate dead-end roads to occupied habitat, and if there were any road developments between them, it would provide more access to occupied habitat.

**Stressor:** • Vulnerability Based on Small Population Size
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing in 1987, the species was known to exist in only six population centers in four counties of the Nebraska Sandhills. Approximately 7000 plants occurred on less than 10 hectares (25 acres). The small populations known at the time were thought to make the species vulnerable to localized environmental changes. In addition, the species occupies a successional niche in the development and eventual revegetation of blowout habitats. As the vegetation in these areas increases, blowout penstemon undergoes local extirpation. At the time of listing, the species was not only rare, but did not appear vigorous at the known localities in Nebraska, possibly because these blowouts had reached a stage of revegetation that exceeded the optimum habitat conditions for the species. Furthermore, the number of new blowouts was decreasing (USFWS 1987). In Wyoming, 3 populations (in addition to 6 subpopulations). The isolation of these populations from each other, as well as the isolation of these populations from other blowout penstemon populations in Nebraska, makes the Wyoming populations similarly vulnerable to the threat of random stochastic events (such as prolonged drought, introduction of invasive species) that could lead to reduction or loss of these populations.

**Stressor:** • Natural Threats
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Damaging insects and periods of drought may be the greatest natural threats to the survival of this species (USFWS 1992). Prior to the drought of the 1930's, the blowout penstemon was listed as one of the most common species in sand blowouts. Following the drought of the 1930's which severely influenced the vegetation of the Great Plains, the blowout penstemon was thought extinct until it was rediscovered in Nebraska in 1959. At one time, it was thought that a localized drought of a few years duration could eliminate most of the remaining blowout penstemon plants in Nebraska (USFWS 1992). o Destructive insects may be a primary cause of decline in populations (USFWS 1992). Several insects (and arachnids) have been observed feeding on blowout penstemon plants, including spider mites, grasshoppers, and an insect larvae which burrows into the inflorescence. Populations of invertebrates are generally at low levels. However, large numbers of penstemon aphids (Aphis pentstemonicola) were observed on two individual transplanted blowout penstemon plants growing in a blowout near Alliance, Nebraska. Foliage of the infested plants appeared wilted, grayish-green, and stunted. Several seed predators have also been found active on blowout penstemon. The most serious insect threat appears to be the pyralid moth. Larvae of a pyralid moth did extensive damage to one population of blowout penstemon in 1990. Adult female pyralid moths deposit their eggs on blowout penstemon plants. After hatching, the larvae burrow into the stems and are active until reaching the pupal stage. These larvae damage or kill blowout penstemon plants by boring into the crown area below the plant's buds.

**Stressor:** • Disease
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Blowout penstemon plants are also quite susceptible to fungal root rots. Plants infected with these fungi wilt, rot, and usually die (USFWS 1992).

**Stressor:** • Encroachment by Other Plants
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The blowout penstemon is well adapted to the rigorous environment of an actively eroding blowout, but it does not grow in close association with most other plants. It generally grows as widely spaced plants in nearly bare sand indicating that these plants may not have the ability to compete with each other or plants of other species for moisture. Its associate in Nebraska, blowout grass, does not use large amounts of soil moisture. Blowout penstemon populations in Nebraska have been known to rapidly decline as members of new species, primarily sand bluestem (Adropogon hallii) and prairie sandreed (Calamovilfa longifolia) increase and begin to use significant amounts of soil moisture following stabilization of the sand habitat (USFWS 1992).

***Recovery***

**Reclassification Criteria:**
Blowout penstemon will be considered eligible for reclassification to threatened when: 1. a minimum of 10,000 individuals in at least 5 population groups is established; and 2. the 5 populations have the minimum level of protection that will ensure their continued existence.

Recovery Priority Number: 11C

**Delisting Criteria:**
Blowout penstemon will be considered eligible for delisting when: 1. a minimum of 15,000 individuals in at least 10 population groups, each with a minimum population of 300 plants is established; and 2. the 10 populations are demonstrated to be at minimum viable population level s.

**Recovery Actions:**
- 1. Protect and monitor naturally occurring, reintroduced, and introduced populations. 2. Inventory suitable habitat for naturally occurring populations and determine potential reintroduction sites. 3. Conduct research to determine life history, minimum viable population parameters, and management criteria. 4. Establish new populations of blowout penstemon. 5. Establish and implement management plans for each population.

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: x Consider revising the recovery plan so that it considers and incorporates the latest information on the species. x Clarify uncertainties regarding the species’ taxonomy in Wyoming (USFWS, 2022).

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# SPECIES ACCOUNT: *Pentachaeta lyonii* (Lyon's pentachaeta)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 02/28/1997; Pacific Southwest (R8)

**Physical Description**

An annual herb, 6-48 cm tall, with yellow flower heads that bloom in the spring. Each plant may produce 30 or more flower heads. (NatureServe, 2015)

**Taxonomy**

Pentachaeta lyonii was described by Asa Gray (1886) based on a plant collected by William S. Lyon "near Palos Verdes Mountain" in Los Angeles County. David D. Keck (1958) combined Pentachaeta with Chaetopappa and published the combination Chaetopappa lyonii. This was recognized by Munz and Keck (1959) and Munz (1974). Van Horn (1973) conducted a taxonomic status of Pentachaeta and Chaetopappa and demonstrated that the two genera were distinct in morphological, anatomical features, and breeding systems. This treatment has been followed in current floristic treatments (Raven et a/. 1986, Lane 1993) (USFWS, 1999).

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to coastal southern California, where currently known only from eastern Ventura and western Los Angeles Counties, in the Santa Monica Mountains and western Simi Hills (CNDDB 2008 cited in USFWS 2008). Formerly also known from the Palos Verdes Peninsula and Santa Catalina Island, but now believed historical/extirpated from these areas (CNDDB 2008 cited in USFWS 2008). (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 12/14/2006.

**Legal Description**

On November 14, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective 12/14/2006) for Pentachaeta lyonii (Lyon's pentachaeta) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in California (71 FR 66374-66423).

**Critical Habitat Designation**

The critical habitat designation for Pentachaeta lyonii includes six CHUs in Ventura, and Los Angeles Counties, California. Approximately 3,396 ac (1,372 ha) fall within the boundaries of the critical habitat designation. The critical habitat units are located in Ventura and Los Angeles Counties, California. Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule. (USFWS, 2006).

Unit 1: Simi Valley Unit: This unit is located east of Moorpark and west of Simi Valley in Ventura County and consists of 390 ac (157 ha) of private land. This unit is divided into four subunits (subunits 1a, 1b, 1c, and 1d) and mapped from occurrences known at the time of listing. The subunits are in the same geographic area; they are all within 2.5 mi (4000 m) of each other.

Unit 2: Montclef Ridge Unit: This unit is located along Montclef Ridge, northwest of Newbury Park in Ventura County. It consists of 892 ac (361 ha) of local agency land (Lynmere, Wildwood Park, and Mount Clef Ridge) owned and managed by COSCA and Conejo Recreation and Parks District, and 265 ac (107 ha) of private land. This unit is divided into three subunits (subunits 2a, 2b, and 2c) that occur within the same geographic area, and are mapped from occurrences known at the time of listing and one occurrence identified after listing.

Unit 3: Thousand Oaks Unit: This unit is located in Thousand Oaks near Lake Sherwood in Ventura and Los Angeles Counties. It consists of 671 ac (272 ha) of local agency land (COSCA, Las Virgenes Metropolitan Water District, and Mountain Resources Conservation Authority) and 588 ac (238 ha) of private land. This unit is divided into three subunits (Subunits 3a, 3b, 3c (eastern portion), and 3d (western portion)) mapped from occurrences known at the time of listing and two occurrence identified after listing.

Unit 4. Triunfo Canyon Unit: This unit is located in unincorporated Los Angeles County. It consists of 197 ac (80 ha) of local agency land owned by Mountains Recreation and Conservation Authority, and 9 ac (3 ha) of private land. It is mapped from an occurrence known at the time of listing and includes multiple patches within a large, single population complex.

Unit 5: Mullholland Drive Unit: This unit is located in the Santa Monica Mountains in Los Angeles County and consists of 105 ac (42 ha) of Federal land (Santa Monica Mountains National Recreation Area) and 187 ac (75 ha) of private land. It is divided into 4 subunits (Subunites 5a, 5b, 5c, and 5d) mapped from occurrences known at the time of listing and occurrences identified after listing.

Unit 7: Malibu Lake Unit: This unit is located in the Santa Monica Mountains in Los Angeles County and consists of 58 ac (23 ha) of State land (Malibu Creek State Park) and 34 ac (14 ha) of private land. It is mapped from an occurrence known at the time of listing.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Pentachaeta lyonii critical habitat consists of three components (71 FR 66374-66423):

(i) Clay soils of volcanic origin;

(ii) Exposed soils that exhibit a microbiotic crust, which may inhibit invasion by other plant competitors; and

(iii) A mosaic of bare ground (>10%) patches in an area with less than 60 percent cover.

**Special Management Considerations or Protections**

Threats that may require special management are specified in the Final Rule for each Critical Habitat Unit: Unit 1. The invasion of annual grasses and nonnative plants that could crowd out P. lyonii, and grazing, edge effects from urban development, road maintenance, and vehicle traffic, which could result in removal or trampling of plants. Unit 2: The invasion by annual grasses and nonnative plants that could crowd out P. lyonii; recreation, including equestrian activities, foot traffic, and off-road vehicles, which could result in trampling of plants; illegal dumping, urban development, which could result in removal of plants; and edge effects from existing urban development. Unit 3: Edge effects from urban development, removal of plants for urban development or fuel management, invasion by annual grasses and nonnative plants that could crowd out Pentachaeta lyonii, and equestrian and foot traffic that could result in trampling of plants. Unit 4: The invasion by annual grasses and nonnative plants, which could crowd out P. lyonii, fuel management, which could result in removal of plants, and foot traffic, which could result in trampling of plants. Unit 5: The potential for development, which could result in removal of plants; fuel management, which could also result in removal of plants; and invasion by annual grasses and nonnative plants, which could crowd out Pentachaeta lyonii. Unit 7: Recreation activities such as foot traffic, which may result in trampling of plants. (USFWS, 2006)

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (NatureServe, 2015, USFWS, 2006))

**Reproduction Narrative**

Adult: Pentachaeta lyonii is not capable of self-pollination, but is dependent upon insect pollinators for successful seed production (Fotheringham and Keeley 1998). Pollinators of P. lyonii include digger bees, andrenid bees, and megachilid bees (Braken and Verhoeven 1998; Fotheringham and Keeley 1998). These pollinators are polylectic, meaning that they utilize several plant species within an area (Braken and Verhoeven 1998), and a variety of plants are necessary to sustain pollinator populations. Known pollinators of P. lyonii have the ability to pollinate individual plants up to 1,968 ft (600 m) from the pollen source, suggesting that genetic connectivity occurs between populations that are up to 1,968 ft (600 m) apart from each other. (USFWS, 2006). Seeds have deciduous pappus bristles, suggesting that this species is not often dispersed long distances by wind. However, seeds of species in this family (Asteraceae) are also sometimes transported by small seed-eating mammals and birds (Martin et al.1961 cited in USFWS 2008). This species' seeds likely persist in the soil for several years during extended dry spells (Fotheringham and Keeley 1998 cited in USFWS 2008).; Predominantly outcrossing; SEXUAL; BIOTIC; Hymenoptera (NatureServe, 2015).

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species occurs in saddles between hills, on the tops of small knolls, or in flat areas at the base of slopes. Plants are found within small open, grassy sites that intergrade with fire-adapted chaparral and coastal sage scrub; also on road and trail edges. Occupied sites tend to feature a mosaic of bare ground patches in an area with low overall vegetative cover. Tends to occur on exposed, rocky clay soils of volcanic origin that exhibit a microbiotic crust. Does not compete well with dense annual grasses or shrubs; can apparently persist without disturbance if site conditions (e.g. exposed soils with a microbiotic crust) inhibit the growth of plant competitors, otherwise periodic disturbance to remove these competitors may be necessary. 85 - 628 m (USFWS 2008). (NatureServe, 2015)

***Dispersal/Migration***

**Dispersal**

Adult: Wind/mammals (USFWS, 2006)

**Dispersal/Migration Narrative**

Adult: produce on the order of 1,000 seeds. The seeds likely persist in the soil for several years during extended dry spells (Fotheringham and Keeley 1998). Plant seeds are frequently dispersed by a variety of vectors, some which result in short-distance dispersal, and others which result in long-distance dispersal (Cain et al. 2000; Nathan and MullerLandau 2000). The presence of deciduous pappus bristles on the seeds indicates that the plant does not exhibit long-distance dispersal by wind, as do many other species in this family, reducing the likelihood of colonization of new areas and contributing to the limited distribution by this method (Keeley and Baer-Keeley 1992; Fotheringham and Keeley 1998). Longdistance dispersal, however, is likely achieved by transport of seeds by wildlife. Seeds from species within the Asteraceae family are known to be transported by small seed-eating mammals, including ground squirrels (Citellus sp.) pocket mice (Perognathus sp.), kangaroo rats (Dipodomys sp.), and birds, including quail (Lophortyx sp.) (Martin et al. 1961). Small mammals facilitate seed dispersal through consumption and elimination of undigested seed and through seed caching (Cain et al. 2000; Sieg 1987) (USFWS, 2006).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Population Growth Rate:**

This species has apparently been extirpated from the southern portion of its historical range (Palos Verdes Peninsula and Santa Catalina Island) (CNDDB 2008 cited in USFWS 2008). Decline of 50-90%  (NatureServe, 2015)

**Number of Populations:**

41 presumed extant (USFWS, 2024)

**Population Size:**

65,000-70,000 plants (NatureServe, 2015)

**Population Narrative:**

This species has apparently been extirpated from the southern portion of its historical range (Palos Verdes Peninsula and Santa Catalina Island) (CNDDB 2008 cited in USFWS 2008). Decline of 50-90% Approximately 65,000-70,000 plants as of most recent counts, but this species is an annual known to exhibit large year-to-year fluctuations in population size, so this particular number may not have much meaning in terms of the species' long-term persistence. Annual fluctuations are believed to occur in response to external factors such as rainfall and competition with other plant species (USFWS 2008). Approximately 32 occurrences are believed extant, with an additional 5 considered historical. At least 3 occurrences have been extirpated. (NatureServe, 2015). Given the likely persistence of soil seed banks, there were 48 total occurrences in 2019 (Service 2019, p. 3) with 7 either extirpated or possibly extirpated (because of likely development), and 41 presumed extant. Of the presumed extant occurrences, 4 were considered declining, 10 were considered increasing or stable, and 27 were in unknown condition. Currently, because of the three additional Santa Catalina Island occurrences, there are 51 occurrences (Figure 1), with 44 presumed extant occurrences. Of these 44 presumed extant occurrences, four appear to be declining, 12 appear to be increasing or stable, and 28 are in unknown condition (Appendix A).

***Threats and Stressors***

**Stressor:** Urban Development (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of listing, the primary threats to Pentachaeta lyonii were destruction of habitat from urban development. An indirect threat to the species was the influence of urban development on the surrounding environment, which facilitated the introduction of competitive weeds and altered ecosystem processes. Effects of urban development include habitat fragmentation, which reduces gene flow between sites, reduces insect pollinators, and displaces P. lyonii as a result of changes to the structure and composition of pocket grassland communities (i.e., introduction of competitive weeds, changes in local hydrology, and increased gopher activity) (Alberts et al. 1993, Conservation Biology Institute 2000). Gophers are known to till the soil and can facilitate the growth of annual grasses. One site was extirpated in 1993 after the site was burned and non-native annual grasses and gophers became prevalent at the site (CNDDB 2008) (USFWS, 2008).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Inadequacy of existing regulatory mechanisms was identified in the final listing document as a threat in determining endangered status for Pentachaeta lyonii. The species is listed as endangered under the California Endangered Species Act (CESA). Although CESA prohibits "take" of State-listed plants, this appears to be inadequate to protect against the taking of plants via habitat modification or land use change by landowners. After the California Department of Fish and Game (CDFG) notifies a landowner that a State-listed plant grows on his or her property, CDFG Code only requires that the landowner notify CDFG "at least 10 days in advance of changing the land use to allow salvage of such plant" (chapter 10 sec. 1913). Determinations by local lead agencies under the California Environmental Quality Act (CEQA) have resulted in negative impacts to P. lyonii (62 FR 4172). Because the intent of CEQA is to disclose project impacts, proposed mitigation measures do not necessarily guarantee protection and conservation of sustainable populations of P. lyonii (USFWS, 2008).

**Stressor:** Fire (USFWS, 2008)
**Exposure:**
**Response:**

**Consequence:** Loss of habitat
**Narrative:** Despite efforts to suppress fires in coastal southern California, the present fire frequency of every 15 years or less, is substantially higher than it was historically, which is thought to be every 50 to 100 years (Keeley 2006). Over a period of 60 years, most of the Santa Monica Mountains burned an average of three to five times, with an average interval of every 12.4 to 20.7 years (Radtke et al. 1982). This current fire frequency may have negatively impacted Pentachaeta lyonii by displacing chaparral and coastal sage scrub communities with annual invasive grasses that displace P. lyonii. In addition, fire prevention and suppression activities such as spraying fire retardant and discing the soil around urban development remains a threat because it facilitates the growth of annual grasses (USFWS, 2008).

**Stressor:** Human recreation (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** Some light recreation is thought to be compatible and even beneficial to the species. Trails create a zone of compacted soils, and may reduce competition from annual grasses and allow Pentachaeta lyonii to grow. One of the largest populations, with a population of 100,000 plants reported, occurs alongside a popular trail (CNDDB 2008). However, higher intensity uses such as equestrian or vehicle use is a threat to the species. A portion of the population on NPS land was severely reduced after an increase in equestrian use (CNDDB 2008). The remaining portions of the population have been fenced and have shown some signs of recovery (NPS unpublished data 2007) (USFWS, 2008).

**Stressor:** Stochastic extinction (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Extinction
**Narrative:** Ten of the 30 known occurrences have greater than 10,000 plants; the remaining populations are small, with several reported at less than 1,000 plants (CNNDB 2008; Appendix A). The small populations are vulnerable to extirpation by demographic, environmental, and genetic stochasticity, and natural catastrophes (Shaffer 1981). Demographic stochasticity is random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of Pentachaeta lyonii. Environmental stochasticity refers to annual variation in birth and death rates in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981). This could play a role in extirpations of small populations because the species exhibits large annual fluctuations in population size, probably in response to external factors such as rainfall and competition with other plant species. Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations (Arias et al. no date) could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). Natural catastrophes such as fire, landslide, or prolonged drought could result in extirpation of populations (Shaffer 1981). The entire range of P. lyonii occurs within a distance of 24 km (15 mi); therefore, all populations would be expected to experience similar rainfall patterns or could be affected by a single fire (USFWS, 2008).

**Stressor:** Climate change (USFWS, 2008)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. 2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. The Santa Monica Mountains is expected to increase in diversity becoming one of these potential future refugia (Loarie et al. 2008). These increases in species diversity in the refugia, due to climate change, have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" to the species present (Loarie et al. 2008) with unknown consequences to the species present. We recognize that climate change is an important issue with potential effects to listed species and their habitats. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Pentachaeta lyonii, small ranged species, such as Pentachaeta lyonii, are more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
1. When 10 populations of 10,000 or more plants, from the 30 current sites (see Table 2 of the Recovery Plan), are fully protected and self-sustaining (as demonstrated through monitoring) (USFWS, 1999)

2. When the populations from Reclassification Critieron 1 are managed to control threats such as alien plants (USFWS, 1999)

3. When the populations from Reclassification Criterion 1 are self-sustaining over a minimum of 15 years (or longer, if data suggest large population fluctuations). (USFWS, 1999)

Recovery Priority Number: 11C

**Delisting Criteria:**
1. When 20 populations of 10,000 or more plants, from the 30 current sites (see Table 2 of the Recovery Plan), are fully protected and self-sustaining (as demonstrated through monitoring) (USFWS, 1999)

2. When the populations from Delisting Critieron 1 are managed to control threats such as alien plants (USFWS, 1999)

3. When the populations from Delisting Criterion 1 are self-sustaining over a minimum of 15 years (or longer, if data suggest large population fluctuations). (USFWS, 1999)

**Recovery Actions:**

- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).
- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)
- Recommendations for Future Actions from 2019 5-Year Review: • Increase monitoring of within and among mainland occurrences for better understanding of population trends. • Monitor the Santa Catalina Island occurrence for better understanding of population numbers, trends, and geographic extents. • Collect additional seed for banking from both mainland and Santa Catalina Island occurrences. • Augment existing occurrences when possible. • Search for additional suitable outplanting locations on protected lands and establish new occurrences. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Explore private land acquisition to conserve Lyon’s pentachaeta occurrences and habitat. Work with private, local, state, and federal partners to identify and leverage funding. 2. Monitor mainland occurrences, especially larger occurrences, for better understanding of population trends. 3. Manage the habitat for the species on Santa Catalina Island to provide protected suitable habitat. This should include removal or effective exclusion of deer and bison, and appropriate landscape recovery efforts. 4. Monitor the Santa Catalina Island occurrences for better understanding of occurrence sizes, trends, and geographic extents. 5. Collect additional seed and increase the number of occurrences represented in conservation seed banks, especially for Santa Catalina Island. 6. When possible, augment existing occurrences with seed derived from within those occurrences. 7. Search for additional suitable mainland outplanting locations on protected lands and establish new occurrences. (USFWS, 2024)

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# SPECIES ACCOUNT: *Phacelia argentea* (Sand dune phacelia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened

**Physical Description**

Sand dune phacelia is an herbaceous flowering perennial with many branching stems arising from a flattened mat. The 1-2 inch (2.5 - 5 centimeter) long, deeply veined leaves are covered with long silvery hairs, and are either entire or with two basal lobes. White flowers include five stamens with rounded heads and are generally present from May through August. Fruits are produced from June through August, with seeds dropping onto the adjacent sand at maturity (USFWS, 2021).

**Taxonomy**

Sand dune phacelia was first described and determined to be a distinct species in 1916 (Nelson and MacBride 1916, p. 34). The plant described (i.e., the type specimen) was collected in 1884 from what was described as a sandy seashore at Chetco, in Curry County, Oregon. Its accepted taxonomy (ITIS 2020) is as follows: Kingdom: Plantae Phylum: Anthophyta Class: Magnoliopsida Superorder: Asteranae Order: Boraginales Family: Boraginaceae (formerly Hydrophyllaceae). Genus: Phacelia Species: argentea

**Current Range**

California, Oregon.  Sand dune phacelia is documented to occur from about 5 miles (8 kilometers) north of Bandon, Oregon, south to Crescent City, California (Figure 1: Distribution map of Phacelia argentea). Whether the species was ever present or abundant elsewhere is unknown. In 1933, sand dune phacelia was reportedly collected from one location in Clatsop County, on Oregon's northern coast (ODA 2020, no pagination), and in 1991, a specimen was reported from Mendocino County, California (Calflora 2020, no pagination). The Mendocino, California location has not been confirmed by the Service and the location that it was reported from does not appear to be suitable habitat (L. Goldsmith 2020, pers. comm.). Other than these two occurrences, sand dune phacelia populations have been reported only from Coos and Curry Counties in Oregon, and Del Norte County in California (USFWS, 2021).

**Critical Habitat Designated**

Yes; 9/21/2023.

**Legal Description**

We, the U.S. Fish and Wildlife Service (Service), list the sand dune phacelia (Phacelia argentea), a plant species from coastal southern Oregon and northern California, as a threatened species with a rule issued under section 4(d) of the Endangered Species Act of 1973, as amended (Act). We also designate critical habitat for the species under the Act. In total, approximately 180.8 acres (73.2 hectares) within 13 units in Coos and Curry Counties in Oregon, and Del Norte County in California, fall within the boundaries of the critical habitat designation. This rule extends the protections of the Act to this species and its designated critical habitat.

**Critical Habitat Designation**

Critical habitat units are depicted for Coos and Curry Counties, Oregon, and Del Norte County, California

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the physical or biological features essential to the conservation of the sand dune phacelia consist of the following components:

(i) Sandy coastal dune habitat above the high tide line that provides a high light environment, room for growth, and adequate moisture.

(ii) A sufficiently abundant pollinator community (which may include leafcutter bees and bumble bees) for pollination and reproduction.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. In the case of the sand dune phacelia, these essential features include sandy dune habitat with high light exposure and adequate moisture and unvegetated space, as well as a sufficiently large and diverse pollinator community, and a minimum of 25 reproductively mature sand dune phacelia plants within dispersal distance of one another to sustain a population. These features essential to sand dune phacelia conservation may require special management considerations or protection to reduce the threat of invasive species encroachment, and to withstand climate change effects such as drought and sea level rise. In addition, localized stressors related to recreational activity, such as off-road vehicle use and pedestrian or equestrian trampling, may also need to be mitigated by special management practices to maintain the sandy open dune habitat that sand dune phacelia populations require. Management activities that could ameliorate these threats include, but are not limited to: (1) Habitat restoration activities in sand dune habitat that include the removal of invasive species such as nonnative European beachgrass and gorse, or native successional species such as shore pine; (2) efforts to restore a diverse and abundant pollinator community, such as through restricting land management practices that harm pollinator species, or through support of a diverse native nectar plant community; (3) access restrictions and enforcement for off-road vehicle use in areas occupied by the sand dune phacelia; and (4) recreational restrictions to prevent damage to sandy coastal dune habitat and the pollinator communities that support the species by pedestrians or equestrians. These management activities will protect the physical or biological features essential for the conservation of the sand dune phacelia by providing native sandy dune habitat that allows for sand dune phacelia population growth and expansion, supporting the pollinator community that enables sand dune phacelia reproduction, protecting sand dune phacelia populations from trampling and crushing, and maintaining an adequate number of sand dune phacelia individuals necessary to sustain viable populations.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Cross-pollination

**Lifespan**

Adult: Unknown

**Breeding Season**

Adult: bloom in late April and May, with flowers persisting through August (USFWS, 2021).

**Reproduction Narrative**

Adult: Reproductively mature plants begin to bloom in late April and May, with flowers persisting through August (Meinke 1982, p. 282) (Figure 3). Sand dune phacelia appears to be largely incapable of significant self-pollination (Meinke 2016, p. 3), relying upon pollination by leafcutter bees (Anthidium palliventre), bumblebees (Bombus spp.), and honeybees (Apis melifera; Rittenhouse 1995, p. 8). Ants (Formica spp.) and beetles (unidentified spp.) were also reported by Rittenhouse as potentially pollinating sand dune phacelia as they travel from plant to plant. Meinke (2016, p. 3) found that sand dune phacelia plants can produce large crops of fertile seeds, and that typical populations usually include several large plants that carry the burden of sexual reproduction and recruitment, producing thousands of seeds over a growing season (USFWS, 2021).

**Habitat Type**

Adult: Terrestrial

**Dependencies on Specific Environmental Elements**

Adult: Dunes/coastal bluffs (10-40 ft elevation)

**Geographic or Habitat Restraints or Barriers**

Adult: Coastal

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2021)

**Habitat Narrative**

Adult: Sand dune phacelia occurs on the open sand above the high tide line, further inland on semi-stabilized and open dunes, and on coastal bluffs (Kalt 2008, p. 2). It has been described as occurring at elevations ranging from 10-40 feet (33 to 131 meters) and on slopes less than 30 percent comprised of sand or (rarely) gravel (USFWS, 2021).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not likely to disperse and colonize new areas without human intervention (USFWS, 2021)

***Population Information and Trends***

**Population Trends:**

Declining. 16 of the 22 populations (63 percent) for which we estimated a trend are declining (Tables 3, 4) (Brown 2020 database). Downward trends are most often associated with low habitat condition (12 populations, or 54 percent), and 68 percent of all populations are in low condition overall when considering all three parameters (habitat, abundance, and trend). Given the preponderance of sand dune phacelia populations in currently low condition, resiliency is low rangewide for most populations (USFWS, 2021).

**Resiliency:**

Seventeen of 25 extant populations (68 percent) are considered low in abundance, with 12 populations (48 percent) containing fewer than 25 individuals (USFWS 2021, pp. 38, 41). Based on what we know about historical abundance, 16 of the 22 populations (73 percent) for which we estimated a trend are declining. Downward trends are most often associated with low habitat condition (12 of 22 populations, or 54 percent), and 68 percent of all populations are in low condition overall when considering all 3 parameters (habitat, abundance, and trend). Given the preponderance of sand dune phacelia populations in currently low condition, resiliency is low rangewide for most populations (USFWS, 2023).

**Representation:**

Representation units were delineated by dividing the rangewide population into logical breaks based on geography and State boundaries. There are nine populations in the Oregon North Unit, six in the Oregon South Unit, and ten in California (Figure 1). Overall current condition is ranked as low in 55 percent of the populations in Oregon North, 67 percent of the populations in Oregon South, and 78 percent of the populations in California. Currently, populations of sand dune phacelia are patchy and dispersed, often isolated by large tracts of habitat made unsuitable by human development or invasive species and are thus unlikely to be able to colonize new areas. The lack of connectivity between populations may result in reduced gene flow and genetic diversity, rendering the species less able to adapt to novel conditions. Further, the lack of available and unoccupied suitable habitat leaves less opportunity for an adaptable species to exploit new resources outside of the area it currently occupies. Thus, ecological diversity is generally low for this highly specialized species, and the limited availability of suitable habitat limits the potential for this species to adapt to environmental changes (adaptive capacity). However, the species currently retains representation with multiple populations in all three representation units, even if those populations are small and resiliency is low (USFWS, 2023).

**Redundancy:**

There are currently approximately 33,858 naturally occurring sand dune phacelia plants existing in 25 extant populations along approximately 100 miles (161 kilometers) of coastline. However, 71 percent of these plants occur in Oregon on private land at the northernmost extent of the range. Of the remaining 14 sites in Oregon, almost all are in public ownership (mostly on OPRD lands), with two on BLM lands. In California, all 10 of the sites include some public land, with a few sites also containing portions of private lands. In Oregon, 60 percent of extant populations are considered in low condition. In California, 80 percent are considered in low condition. Rangewide, 12 of the 25 extant populations have fewer than 25 individuals. Our analysis of redundancy concludes that although most populations exhibit low resiliency, it is unlikely that a single catastrophic event could eliminate all extant populations. Populations are well distributed throughout all representation units, with the highest-condition populations located at either end of the species’ range (USFWS, 2023).

**Number of Populations:**

25 Extant Populations (USFWS, 2021).

**Population Size:**

Populations range in size from ~33,858 (USFWS, 2023)

**Minimum Viable Population Size:**

Unknown (USFWS, 2021)

**Population Narrative:**

Populations delineated as spatially explicit by ORBIC and the California Natural Diversity Database (CNDBB) were used as the analytic units for this assessment (see Methodology, Chapter V). Spatially explicit populations of sand dune phacelia are defined differently in Oregon and California. In California, individual plant mats that are separated by a 0.25-mile (0.4-kilometer) interval are considered separate populations, whereas in Oregon the threshold for distinct populations is 0.30 miles (0.48 kilometers). Beyond these limits, gene flow is considered improbable.  Sand dune phacelia is documented to occur from about 5 miles (8 kilometers) north of Bandon, Oregon, south to Crescent City, California (Figure 1: Distribution map of Phacelia argentea). Whether the species was ever present or abundant elsewhere is unknown. In 1933, sand dune phacelia was reportedly collected from one location in Clatsop County, on Oregon's northern coast (ODA 2020, no pagination), and in 1991, a specimen was reported from Mendocino County, California (Calflora 2020, no pagination). The Mendocino, California location has not been confirmed by the Service and the location that it was reported from does not appear to be suitable habitat (L. Goldsmith 2020, pers. comm.). Other than these two occurrences, sand dune phacelia populations have been reported only from Coos and Curry Counties in Oregon, and Del Norte County in California (USFWS, 2021).  Sand dune phacelia is documented to occur from about 5 miles (8 kilometers) north of Bandon, Oregon, south to Crescent City, California (Figure 1: Distribution map of Phacelia argentea). Whether the species was ever present or abundant elsewhere is unknown. In 1933, sand dune phacelia was reportedly collected from one location in Clatsop County, on Oregon's northern coast (ODA 2020, no pagination), and in 1991, a specimen was reported from Mendocino County, California (Calflora 2020, no pagination). The Mendocino, California location has not been confirmed by the Service and the location that it was reported from does not appear to be suitable habitat (L. Goldsmith 2020, pers. comm.). Other than these two occurrences, sand dune phacelia populations have been reported only from Coos and Curry Counties in Oregon, and Del Norte County in California (USFWS, 2021).

***Threats and Stressors***

**Stressor:** Invasive Plants
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive, introduced plant species are reportedly one of the most influential stressors to sand dune phacelia and its habitat (Kalt 2008, p. 7; Rodenkirk 2019, p. 6). European beachgrass, gorse, and other invasive plant species outcompete sand dune phacelia throughout its range (Rodenkirk 2019, p. 6). Introduced to the Pacific Northwest region of the United States and California in the 1800s, European beachgrass is an aggressive, perennial, rhizomatous grass. It was extensively planted to stabilize sand and build dunes parallel to the ocean shore in an effort to protect infrastructure from the effects of ocean storms and tides (Hacker et al 2011, p.

2; ODFW 2016a, pp. 6-7). Prior to the introduction of European beachgrass, the dunes of the Oregon and northern California coasts rose gradually from the beach and sand moved in patterns reflecting the prevailing wind directions. Dunes ran perpendicular to the coast, and the plant community was comprised of native plants adapted to shifting sand. Colonizing European beachgrass captured sand with its deep roots and spreading shoots, forming dense monocultures of grass that outcompeted many native dune species, including sand dune phacelia, for growing space, sunlight, and moisture (Rittenhouse 1996, p. 3). The steep, heavily vegetated foredunes seen today along much of the Oregon, and to a lesser extent California, coastlines are the result of European beachgrass colonization (Rittenhouse 1995, p. 9; Zarnetske et al. 2010, pp. 1-2). Dune stabilization by European beachgrass also facilitates the establishment and succession of native trees and shrubs that proliferate in the absence of natural disturbance regimes, thereby resulting in the conversion, and ultimate loss, of native dune habitat.

**Stressor:** Human Activity (Recreation)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Legal and illegal off-highway vehicle (OHV) use can damage or kill sand dune phacelia. While widely perceived as a threat (Kalt 2008, p. 9; Brown 2020 database; Rodenkirk 2019, p. 6), documented impacts from OHVs are limited to individuals at a small number of sites throughout its range, most notably in California (Imper, 1987, p. 1; Gedik 2009, p. 7; Tolowa Dune Stewards 2013, p. 18; Jacobs 2019, pp. 15, 102). Rittenhouse (1995, p. 9) described the impact of OHV use to be minimal and localized in Oregon, and while he noted some damage to individuals at two sites (Lost Lake and Ophir Dunes), he and Kalt (2008, p. 9) reported that most OHV use occurs in areas unoccupied by sand dune phacelia. Rodenkirk (2019, p. 22) speculated that illegal OHV use may have contributed to the decline of the population at Fourmile, and Forys (2020, pers. comm.) expressed concern that illegal OHV use may be impeding the recovery of sand dune phacelia at the Lake Tolowa Restoration and East Dead Lake sites. Jerabek (2020a, pers. comm.) concurred, and described OHV use as an ongoing and pervasive issue for the California populations. Legal vehicle use may also impact sand dune phacelia where roads bisect populations, or populations which are located on beaches that are designated as open to motorized vehicle use (Brown 2020 database). Trampling by pedestrians and equestrians is noted as a concern throughout the range of sand dune phacelia.

**Stressor:** Private Land Development/Management (Coastal Development)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Coastal development activities that may affect sand dune phacelia include the maintenance and construction of roads, airports, utilities, and buildings.

**Stressor:** Livestock Grazing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Negative effects of livestock grazing on sand dune phacelia are undocumented. Livestock grazing does occasionally occur throughout the range of sand dune phacelia on private lands; however it usually occurs on well-stabilized (i.e., vegetated) dunes and coastal meadows,

which are not ideal sand dune phacelia habitat. Rodenkirk (2019, p. 22) speculated that grazing may have actually benefitted sand dune phacelia at the Fourmile site by reducing competition from invasive species. A nearby population occurring on a grazed, private ranch was presumed to be doing well, but no data were presented to substantiate this claim, or upon which to draw a correlation (Kalt 2008, p. 10). Furthermore, grazing was not listed as a threat by Brown (2020 database) for any of the populations surveyed. Therefore, we did not include livestock grazing as a threat influencing the current and future conditions of sand dune phacelia populations.

**Stressor:** Overutilization
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because of its attractive foliage, illegal removal for horticultural purposes has been cited as a threat to sand dune phacelia (Rodenkirk 2019, p. 6; ODA 2020, no pagination). We could find no information with which to validate this claim, or assess its impacts on sand dune phacelia populations, thus we did not consider overutilization as a threat influencing the current and future conditions of sand dune phacelia populations.

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Phacelia insularis ssp. insularis* (Island phacelia)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An annual herb, usually about 1.5 dm tall. Small lavender to violet, bell-shaped flowers bloom in March and April. (NatureServe, 2015)

**Taxonomy**

The summary and table of the July 31, 1997 notice in the Federal Register (in which the USFWS determines this taxon as endangered) lists the taxon as Phacelia insularis SSP. insularis; in the text the taxon is referred to as a subspecies and as a variety. The treatment the notice appears to follow is Wilken et al. (1993; in Hickman) which treats the taxon as a variety. (NatureServe, 2015)

**Historical Range**

Endemic to the California Channel Islands and, at the time of listing in 1997, a single population on Santa Rosa Island was the only known population of the species. By the time the recovery plan was published in 2000, island phacelia was known to occur in five localities: the one on Santa Rosa Island at Carrington Point and the four on San Miguel Island (see Santa Rosa Island and San Miguel Island maps, pp. 15-16). Both islands occur on lands managed by Channel Islands National Park (Park). The Santa Rosa Island population occupies about 15 acres (6 hectares (ha)) based on its maximum observed extent in 1998. The San Miguel Island populations range from about 0.02 to 0.86 acres (0.01 to 0.35 ha). These figures are from USGS surveys made in April and May, 1998, when the largest number of plants were observed (McEachern in litt. 2007b). Surveys since 1998 have not seen such extensive numbers of plants in those same areas; however, a seed bank likely still exists (McEachern in litt. 2007b). (USFWS, 2008)

**Current Range**

This variety occurred only in Santa Rosa and San Miguel Islands, Santa Barbara county, California. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Currently, little life history information is available for this species. This annual flower blooms from March through April (USFWS, 2000).

**Habitat Type**

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015). The plant is found on stabilized sand dunes at 50–200 meters elevation. It occurs in non-native annual grassland, usually in bare openings within the grass thatch. (USFWS, 2025)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

6 EOs (USFWS, 2021)

**Population Narrative:**

USFWS reports a population of 31 plants from Santa Rosa Island in 1994. No populations have been relocated in San Miguel Island. As of 2001, no populations exist. The California Natural Diversity Database (May/1998) reports four occurrences, none of which have been observed in the last 20 years; but USFWS (1997) reports that Sarah Chaney found one small population in 1994 in Santa Rosa Island. (NatureServe, 2015). Low redundancy, representation and resiliency are inferred based on low population numbers and low number of individuals.

***Threats and Stressors***

**Stressor:** Predation (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Some progress has been made toward eliminating non-native animals from Santa Rosa Island since the time of listing. We believe the removal of pigs by 1993, removal of cattle by

1998, and smaller populations of deer and elk since 1998 have reduced browsing pressure on island phacelia. Although habitat conditions on Santa Rosa Island and San Miguel Island show the effects of long-term grazing, the USGS believes that at the landscape level, conditions are improving (McEachern in litt. 2007b). In fact, browsing by an animal is rarely seen, although predation does occur from mice that are known to harvest the fruits (McEachern in litt. 2007b) (USFWS, 2008).

**Stressor:** Non-native plants (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Invasion of habitats by non-native annual grasses, especially ripgut brome, continues to impact the species, particularly germination. Non-native annual grasses and the litter they produce also appear to inhibit successful establishment of phacelia seedlings in field experiments (McEachern in litt. 2007b, Levine et al. 2007) (USFWS, 2008).

**Stressor:** Small population size (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of genetic variability/extinction
**Narrative:** At the time of listing, island phacelia was threatened by the risk of stochastic extinction due to small population size and limited distribution (62 FR 40954). The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, the small size of each population makes it difficult for this species to persist while sustaining the impacts of soil damage and habitat alteration from non-native species. The species remains vulnerable to extirpation due to its small population size, high inter-annual variability in plant numbers, limited distribution, and low survival rate (USFWS, 2008).

**Stressor:** Climate change (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Island phacelia may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap regions that would be climatically favorable in the future (Levine et al. 2007). This is particularly acute for species on islands because they are unable to disperse to more favorable habitat as the environment changes. Because of this, Levine et al. (2007) suggest that the persistence of many rare species depends on how populations respond to climate change in their current locations (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
1. Discover or establish 10 populations per island (San Miguel and Santa Rosa) (USFWS, 2021)

2. Maintain stable populations for a period of 15 years that includes the normal precipitation cycle. (USFWS, 2021)

3. Seed stored in CPC cooperating facilities. (USFWS, 2021)

4. Seed germination and propagation techniques understood. (USFWS, 2021)

5. Successful outplanting techniques developed (USFWS, 2021)

6. Life history research conducted. (USFWS, 2021)

7. Weed management plan developed and implemented. (USFWS, 2021)

8. If declining, determine cause and reverse trend. (USFWS, 2021)

Recovery Priority: 6.

**Delisting Criteria:**
Discover or establish five additional populations per island (USFWS, 2008).

No decline after downlisting for 10 years (USFWS, 2008).

All potential habitat surveyed. (USFWS, 2021)

**Recovery Actions:**
- Reclassification Criteria: Although surveys in historical and other suitable habitat have been conducted, additional populations have not been found and no reintroduced populations have been established on Santa Rosa Island. Therefore, this criterion has not been met. We believe this criterion may be possible on San Miguel Island because, although these plants have every specific habitat requirements, there are several places on the island where suitable habitat conditions exist and the plant now occurs (McEachern, in litt. 2007a). However, this criterion is not appropriate with respect to the recovery of the species on Santa Rosa Island because suitable habitats appear to be extremely rare on the island. Suitable habitat may be available on Carrington Point; otherwise, suitable habitat on the island appears to be limited. Therefore, a more realistic goal would be to establish one additional population on Santa Rosa Island. Results of restoration field experiments over time would help establish whether or not the goal of one more population is feasible (McEachern, in litt. 2007a). Delisting Criteria: This criterion has not been met. We believe this criterion may be possible on San Miguel Island where three populations exist now but it is not realistic with respect to the recovery of the species on Santa Rosa Island for the same reasons described in downlisting criterion #1 above (USFWS, 2008).
- Reclassification Criteria: Delisting Criteria: This criterion has not been met. Although we believe the intent of this criterion is appropriate, we think it should be refined to focus on long-term trends, rather than a short-term, absolute decline, once additional information about the life history of the species and the species' response to recovery actions are better understood. Factor B is not relevant to this species. Factor D is relevant but is not addressed in the recovery criteria (USFWS, 2008).

- Reclassification criteria: A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000). Because the species has not been listed for a minimum of 15 years, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2008).
- The USGS-BRD and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects (USFWS, 2008).
- The Service should work cooperatively with NPS and USGS-BRD to refine the generalized downlisting criteria to take into consideration new information. Attaining the recovery objective of securing several populations containing a minimum of 2,000 plants each is unrealistic for this species (USFWS, 2008).
- The Service should work cooperatively with NPS and USGS-BRD to refine delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines (USFWS, 2008).
- The USGS-BRD and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends (USFWS, 2008).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue monitoring the Santa Rosa Island occurrence of Phacelia insularis var. insularis and establish regular surveys on both Santa Rosa and San Miguel Islands. 2. Better define suitable germination and growth microhabitat for Phacelia insularis var. insularis, especially in relationship to non-native Bromus diandrus competition and thatch accumulation, and if needed determine how to manage Bromus diandrus. 3. Determine efficient methods to reduce Bromus diandrus thatch without harming Phacelia insularis var. insularis individuals. 4. Control non-native Malva psuedolavatera in the Carrington Point area on Santa Rosa Island. 5. Improve the completeness of coverage of Phacelia insularis var. insularis in conservation seed banks, with more occurrences over more years. (USFWS, 2021)
- RECOMMENDATIONS FOR FUTURE ACTIONS: The following list carries over recommendations from the previous 5-year review (Service 2021), and adds an additional one (Recommendation 5). 1. Continue monitoring the Santa Rosa Island occurrence of island phacelia and establish regular surveys on both Santa Rosa and San Miguel Islands to document changes in distribution and abundance. 2. Better define suitable germination and growth microhabitat for island phacelia, especially in relationship to non-native grass Bromus diandrus competition and thatch accumulation, and if needed determine how to manage Bromus diandrus. 3. Determine efficient methods to reduce Bromus diandrus thatch without harming island phacelia seeds or plants. 4. Control non-native Malva multiflora in the Carrington Point area on Santa Rosa Island. 5. Monitor the effects of increased backcountry visitor use on island phacelia, and on the possible increase of non-native plants that could negatively affect the island phacelia. 6. Improve the completeness of coverage of island phacelia in conservation seed banks, with more occurrences over more years. (USFWS, 2025)

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# SPECIES ACCOUNT: *Phacelia submutica* (DeBeque phacelia)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

**Physical Description**

Annual plant, stems 2-8 cm long, often branched at the base, mostly prostrate, leaves hairy, oblong or egg-shaped, flowers crowded, petals 3.5-4.5 mm long, white or cream colored becoming yellowish with age, stamens not protruding beyond the petals. (NatureServe, 2015)

**Taxonomy**

Phacelia submutica was first described by Howell based on specimens collected from the town of DeBeque, Mesa County, Colorado, in 1911 and 1912 (Howell 1944, pp. 370– 371Halse (1981, pp. 121, 129, 130) reduced it to varietal status as P. scopulina var. submutica. This has been challenged as incorrect by O'Kane (1987, p. 2), who claimed Halse used inadequate collection materials, and that P. submutica is geographically isolated from P. scopulina (O'Kane 1987, p. 2; 1988, p. 462). Phacelia submutica is recognized at the species rank by current floristic treatments in Weber and Wittmann (1992, p. 98; 2001, p. 203) and by the Director of the Biota of North America Program (Kartesz 2008, pers. comm.). While the Integrated Taxonomic Information System (2001) database cites John Kartesz as the expert source for this species, it is not updated with his currently accepted name for the species: Phacelia submutica (Kartesz 2008, pers. comm.). Phacelia is included in the Hydrophyllaceae (waterleaf family). Recent molecular data suggest that this family should be combined in an expanded Boraginaceae (borage family). There are conflicting views on the configuration of this larger Boraginaceae and the lead author of the family treatment for the upcoming Flora of North America has chosen to retain the Hydrophyllaceae. Therefore, we will retain Phacelia in the Hydrophyllaceae family for this proposal (USFWS, 2010).

**Current Range**

Phacelia submutica is endemic to Colorado and known only from Garfield and Mesa counties. Estimated range is 356 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences.

**Critical Habitat Designated**

Yes; 8/13/2012.

**Legal Description**

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Phacelia submutica (DeBeque phacelia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

**Critical Habitat Designation**

The critical habitat designation for Phacelia submutica includes nine CHUs in Garfield and Mesa Counties, Colorado. This species critical habitat encompasses approximately 25,484 acres (ac) (10,313 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Sulphur Gulch Unit, consists of 1,046 ac (423 ha) of federally owned land. The Unit is located approximately 7.7 mi (12.5 km) southwest of the town of DeBeque in Mesa County, Colorado. This Unit is managed by BLM, through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 5,480 to 6,320 ft (1,670 to 1,926 m), appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. All lands within this Unit are leased as grazing allotments, and less than 1 percent is managed as an active pipeline ROW by the BLM. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), domestic and wild ungulate grazing and use, and nonnative invasive species, such as Bromus tectorum.

Unit 2, the Pyramid Rock Unit, is the largest Unit we are designating and consists of 17,321 ac (7,010 ha) of federally and privately owned lands in Mesa and Garfield Counties, Colorado. This Unit is approximately 1.6 mi (2.6 km) west of the town of DeBeque. The eastern boundary borders Roan Creek, and Dry Fork Creek runs through the northern quarter of the Unit. Eighty-nine percent is managed by BLM through the Grand Junction Field Office, and 11 percent is under private ownership. Three percent of this Unit is within the Pyramid Rock Natural Area and Pyramid Rock ACEC that was designated, in part, to protect Phacelia submutica, as discussed in the proposed (75 FR 35739) and final listing rules (76 FR 45054). This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,960 to 6,840 ft (1,512 to 2,085 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Ninety-four percent of this Unit is managed as a grazing allotment on BLM and private lands. Additionally, 11 percent of this Unit is managed as an active pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species including Bromus tectorum and Halogeton glomeratus. The Westwide Energy corridor runs through this Unit. The corridor covers almost 10 percent of this Unit (Service 2011c, p. 9).

Unit 3, the Roan Creek Unit, consists of 54 ac (22 ha) of federally and privately owned lands in Garfield County, Colorado. The Unit is located 3.3 mi (5.4 km) north of the town of DeBeque and for 1.7 mi (2.7 km) along both sides of County Road 299. Ninety-seven percent of this Unit is privately owned. Three percent of this Unit is managed by BLM through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent cover, suitable elevational ranges of 5,320 to 5,420 ft (1,622 to 1,652 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. The entire Unit is within a grazing allotment. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include recreation (especially OHV use), livestock and wild ungulate grazing and use, nonnative invasive species including Bromus tectorum and Halogeton glomeratus, and a lack of protections on private lands.

Unit 4, the DeBeque Unit, consists of 530 ac (215 ha) of Federal and private lands in Mesa County, Colorado. This Unit is located 0.25 mi (0.4 km) north of DeBeque between Roan Creek Road and Cemetery Road. Seventy-six percent of this Unit is managed by BLM through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 5,180 to 5,400 ft (1,579 to 1,646 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, residential development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species including Bromus tectorum and Halogeton glomeratus. Since 24 percent of the Unit is privately owned and borders the north of the town of DeBeque, this Unit is threatened by potential urban or agricultural development. The Westwide Energy corridor runs through this Unit. The corridor covers almost 66 percent of this Unit (Service 2011c, p. 9).

Unit 5, the Mount Logan Unit, consists of 277 ac (112 ha) of Federal and private lands in Garfield County, Colorado. The Unit is located 2.7 mi (4.4 km) north, northeast of the town of DeBeque, Colorado, and 0.5 mi (0.8 km) west of Interstate 70. Eighty-eight percent of this Unit is managed by BLM through the Grand Junction Field Office. The remainder of this Unit is privately owned. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,960 to 5,575 ft (1,512 to 1,699 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Eighty-eight percent of this Unit is managed as a grazing allotment by BLM, and 53 percent is managed as an active pipeline ROW. An access road runs through the Unit connecting several oil wells and associated infrastructure. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus.

Unit 6, the Ashmead Draw Unit, consists of 1,276 ac (516 ha) of Federal and private lands in Mesa County, Colorado. The Unit is located 1.5 mi (2.5 km) southeast of the town of DeBeque, Colorado, and east of 45.5 Road (DeBeque Cut-off Road). Eighty-seven percent of this Unit is managed by BLM through the Grand Junction Field Office, the remainder is private lands. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (Service 2011e, pp. 1-3). This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,940 to 5,808 ft (1,506 to 1,770 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. A network of access roads runs through the Unit. Eighty-eight percent of this Unit is within a BLM grazing allotment, and 84 percent is within the Grand Junction Field Office's designated energy corridor. Thirty percent of the Unit is managed as an active pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus. The Westwide Energy corridor runs through this Unit. The entire Unit is within the Westwide Energy corridor, and 88 percent is within several grazing allotments.

Unit 7, the Baugh Reservoir Unit, consists of 430 ac (174 ha) of Federal and private lands in Mesa County, Colorado. The Unit is located 6 mi (10 km) south of DeBeque, Colorado, near Kimball Mesa and Horse Canyon Road. Thirty-nine percent is managed by BLM through the Grand Junction Field Office, and the remaining 61 percent is on private lands. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (Service 2011e, pp. 5-8). This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,400 to 5,700 ft (1,646 to 1,737 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. An access road runs through the Unit, close to the occurrence of Phacelia submutica. While these lands currently have the physical and biological features essential to the conservation of P. submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation, livestock and wild ungulate grazing and use, and nonnative invasive species including Bromus tectorum and Halogeton glomeratus. The Westwide Energy corridor runs through this Unit. The entire Unit is within the Westwide Energy corridor and one grazing allotment.

Unit 8, the Horsethief Mountain Unit, consists of 4,209 ac (1,703 ha) of Federal and private lands in Mesa County, Colorado. It is located approximately 3.5 mi (5.6 km) southeast of DeBeque, Colorado, and along the eastern side of Sunnyside Road (V Road). Thirty-four percent is managed by BLM through the Grand Junction Field Office, 29 percent by the White River National Forest, 23 percent by the Grand Mesa Uncompahgre National Forest, and 14 percent is on private lands. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,320 to 6,720 ft (1,622 to 2,048 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. A portion of the site on USFS lands is within a proposed Research Natural Area. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus.

Unit 9, the Anderson Gulch Unit, consists of 341 ac (138 ha) of State and private lands in Mesa County, Colorado. It is located 11 mi (17 km) southeast of DeBeque, Colorado, and 3.5 mi (5.5 km) north of the town of Molina, Colorado. Within the Unit, 56 percent of the lands are managed by CDOW, within the Plateau Creek State Wildlife Area, and 44 percent is private. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (CNHP 2012b, spatial data). This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,860 to 6,040 ft (1,786 to 1,841 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Forty-two percent of the Unit is a pending pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, special management may be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially from OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Phacelia submutica critical habitat consists of five components (77 FR 48356-48415):

(i) Suitable soils and geology. (A) Atwell Gulch and Shire members of the Wasatch formation. (B) Within these larger formations, small areas (from 10 to 1,000 ft\2\ (1 to 100 m\2\)) on colorful exposures of chocolate to purplish brown, light to dark charcoal gray, and tan clay soils. These small areas are slightly different in texture and color than the similar surrounding soils. Occupied sites are characterized by alkaline (pH range from 7 to 8.9) soils with higher clay content than similar nearby unoccupied soils. (C) Clay soils that shrink and swell dramatically upon drying and wetting and are likely important in the maintenance of the seed bank.

(ii) Topography. Moderately steep slopes, benches, and ridge tops adjacent to valley floors. Occupied slopes range from 2 to 42 degrees with an average of 14 degrees.

(iii) Elevation and climate. (A) Elevations from 4,600 ft (1,400 m) to 7,450 ft (2,275 m). (B) Climatic conditions similar to those around DeBeque, Colorado, including suitable precipitation and temperatures. Annual fluctuations in moisture (and probably temperature) greatly influences the number of Phacelia submutica individuals that grow in a given year and are thus able to set seed and replenish the seed bank.

(iv) Plant community. (A) Small (from 10 to 1,000 ft\2\ (1 to 100 m\2\)) barren areas with less than 20 percent plant cover in the actual barren areas. (B) Presence of appropriate associated species that can include (but are not limited to) the natives Grindelia fastigiata, Eriogonum gordonii, Monolepis nuttalliana, and Oenothera caespitosa. Some presence, or even domination by, invasive nonnative species, such as Bromus tectorum, may occur, as Phacelia submutica may still be found there. (C) Appropriate plant communities within the greater pinyon-juniper woodlands that include: (1) Clay badlands within the mixed salt desert scrub; or (2) Clay badlands within big sagebrush shrublands.

(v) Maintenance of the seed bank and appropriate disturbance levels. (A) Within suitable soil and geologies (see paragraph (2)(i) of this entry), undisturbed areas where seed banks are left undamaged. (B) Areas with light disturbance when dry and no disturbance when wet.

**Special Management Considerations or Protections**

The features essential to the conservation of this species (plant community and competitive ability, elevation, topography, soils, climate, reproduction and seed bank, and disturbance regime) may require special management considerations or protection to reduce threats. Specifically, the clay soils on which Phacelia submutica are found are relatively stable when dry but are extremely vulnerable to disturbances when wet. The current range of P. submutica is subject to human-caused modifications from natural gas exploration and production with associated expansion of pipelines, roads, and utilities; development within the Westwide Energy Corridor; increased access to the habitat by OHVs; soil and seed disturbance by livestock and other human-caused disturbances; nonnative invasive species including Bromus tectorum and Halogeton glomeratus (halogeton); and inadequacy of existing regulatory mechanisms (76 FR 45054). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Development of regulations and agreements to balance conservation with energy development and minimize its effects in areas where the species resides; the establishment of additional protection areas that provide greater protections for the species; minimization of OHV use; placement of roads and utility lines away from the species and its habitat; minimization of livestock use or other human-caused disturbances that disturb the soil or seeds; and the minimization of habitat fragmentation. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, protecting the plant's habitat and soils, and managing for appropriate levels of disturbance. Criteria Used To Identify Critical Habitat As required by section 4(b)(2) of the Act, we used the best scientific data available to designate critical habitat. We reviewed available information pertaining to the habitat requirements of this species. In accordance with the Act and its implementing regulation at 50 CFR 424.12(e), we considered whether designating additional areas-- outside those currently occupied as well as those occupied at the time of listing--are necessary to ensure the conservation of the species. We are designating critical habitat in areas within the geographical area occupied by Ipomopsis polyantha, Penstemon debilis, and Phacelia submutica at the time of listing in 2011. We also are designating specific areas outside the geographical area occupied by I. polyantha and P. debilis at the time of listing because we have determined that such areas are essential for the conservation of the species. All units are designated based on sufficient elements of physical and biological features being present to support Ipomopsis polyantha, Penstemon debilis, and Phacelia submutica life-history processes. Small populations and plant species with limited distributions, like those of Ipomopsis polyantha and Penstemon debilis, are vulnerable to relatively minor environmental disturbances (Given 1994, pp. 66-76; Frankham 2005, pp. 135-136), and are subject to the loss of genetic diversity from genetic drift, the random loss of genes, and inbreeding (Ellstrand and Elam 1993, pp. 217-237; Leimu et al. 2006, pp. 942-952). Plant populations with lowered genetic diversity are more prone to local extinction (Barrett and Kohn 1991, pp. 4, 28). Smaller plant populations generally have lower genetic diversity, and lower genetic diversity may in turn lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Newman and Pilson 1997, p. 360; Palstra and Ruzzante 2008, pp. 3428-3447). Because of the dangers associated with small populations or limited distributions, the recovery of many rare plant species includes the creation of new sites or reintroductions to ameliorate these effects. Genetic analysis of Ipomopsis polyantha has not been conducted; therefore, we do not understand the genetic diversity of this species. Given the species' limited extent and presence in only two populations, we expect the species may be suffering from low genetic diversity, or could in the future. Genetic research on Penstemon debilis, based on neutral genetic markers, has found that there is more genetic diversity in larger populations than smaller populations, that the northeastern populations are more closely related to one another than to the southwestern populations, that inbreeding is common within each population, and that genetic diversity for the species is low when compared with other species of plants with similar life-history traits (Wolfe 2010, p. 1). The plant is partially clonal, which likely explains the lowered genetic diversity and further reduces the actual population size. Small population sizes with few individuals are a problem for this species, as supported by this research. When designating critical habitat for a species, we consider future recovery efforts and conservation of the species. Realizing that the current occupied habitat is not enough for the conservation and recovery of Ipomopsis polyantha and Penstemon debilis, we worked with species' experts to identify unoccupied habitat essential for the conservation of these two species. The justification for why unoccupied habitat is essential to the conservation of these species and methodology used to identify the best unoccupied areas for consideration for inclusion is described below. Habitat fragmentation can have negative effects on biological populations, especially rare plants, and affect survival and recovery (Aguilar et al. 2006, pp. 968-980; Aguilar et al. 2008, pp. 5177-5188; Potts et al. 2010, pp. 345-352). Fragments are often not of sufficient size to support the natural diversity prevalent in an area, and thus exhibit a decline in biodiversity (Fahrig 2003, pp. 487-515). Fragmentation effects are especially prevalent in systems where multiple generations have elapsed since the fragmentation occurred (Aguilar et al. 2008, p. 5177). Habitat fragmentation has been shown to disrupt plant-pollinator interactions and predator-prey interactions (Steffan-Dewenter and Tscharntke 1999, p. 432-440; Aguilar et al. 2006, pp. 968-980; Eckert et al. 2010, pp. 35-43), alter seed germination percentages (Menges 1991, pp. 158-164), affect recruitment (Santos and Telleria 1997, pp. 181-187; Quesada et al. 2003, pp. 400-406), and result in lowered fruit set (Burd 1994, pp. 83-139; Cunningham 2000, pp. 1149-1152; Eckert et al. 2010, p. 38). In general, habitat fragmentation causes habitat loss, habitat degradation, habitat isolation, changes in species composition, changes in species interactions, increased edge effects, and reduced habitat connectivity (Fahrig 2003, pp. 487-515; Fisher and Lindenmayer 2007, pp. 265-280). These effects are more prevalent in arid ecosystems with low native vegetation cover (Fisher and Lindenmayer 2007, p. 272). Habitat fragments are often functionally smaller than they appear because edge effects (such as increased nonnative invasive species or wind speeds) impact the available habitat within the fragment (Lienert and Fischer 2003, p. 597). Shaffer and Stein (2000) identify a methodology for conserving imperiled species known as the three Rs: Representation, resiliency, and redundancy. Representation, or preserving some of everything, means conserving not just a species but its associated plant communities, pollinators, and pollinator habitats. Resiliency and redundancy ensure there is enough of a species so it can survive into the future. Resiliency means ensuring that the habitat is adequate for a species and its representative components. Redundancy ensures an adequate number of sites and individuals. This methodology has been widely accepted as a reasonable conservation strategy (Tear et al. 2005, p. 841). We have addressed representation through our PCEs for each species (as discussed above) and by providing habitat for pollinators of Ipomopsis polyantha and Penstemon debilis (as discussed further under ``Ipomopsis polyantha'' below). For Phacelia submutica, we believe that the occupied habitat provides for both resiliency and redundancy and that with conservation of these areas, the species should be conserved and sustained into the future. For I. polyantha, there are only two known populations, both with few or no protections in place (low resiliency). For adequate resiliency, we believe it is necessary for the conservation and recovery of I. polyantha that additional populations with further protections be established. Therefore, we have identified two unoccupied areas as designated CHUs for I. polyantha. For P. debilis, there are only approximately 4,000 known individuals (low redundancy), all within 2 concentrated areas (low resiliency). For adequate redundancy and resiliency, we believe it is necessary for conservation and recovery that additional populations of P. debilis be established. Therefore, we have identified two unoccupied areas as designated CHUs for P. debilis.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated/Asexual (USFWS, 2013)

**Lifespan**

Adult: One year (USFWS, 2013)

**Breeding Season**

Adult: DeBeque phacelia plants flower between late April and late June and set seed from midMay through late June (USFWS, 2013).

**Reproduction Narrative**

Adult: DeBeque phacelia plants flower between late April and late June and set seed from midMay through late June. Preliminary evidence on the pollination biology of the species indicates that insect pollinators are not necessary for reproduction (Langton and Schupp 2012a). Yearly germination is variable depending on precipitation patterns and can fluctuate widely (Burt and Spackman 1995). For example, DeBeque phacelia numbers at Horsethief Mountain fluctuated from 1,700 plants in 1986, to 50 in 1992, up to 1,070 in 2003, and down to only a few from 2006 to 2008 (Colorado Natural Heritage Program (CNHP) 2010) (Figure 1). This strategy of maintaining seed dormancy through unfavorable conditions is common among annual plant species of arid environments (Anderson et al. 2012; Baskin and Baskin 1998). Maintenance of a large seed bank is also vital to the persistence of these species through unpredictable and long periods of drought (Anderson et al. 2012). No information is currently available on the density and longevity of the species’ seed bank, nor the environmental conditions required to break seed dormancy, but studies are under way (Langton and Schupp 2012b) (USFWS, 2013).

**Habitat Type**

Adult: Ridge tops (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Xeric ridge tops (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: DeBeque phacelia is a rare annual narrow endemic forb found on clay soils of the Wasatch Formation in Mesa and Garfield Counties, Colorado. It is found on slopes that average 14 degrees and elevation bands between 5,026 and 6,424 feet (1,532 and 1,958 meters). It has a short-lived annual growing season, April through June, with seeds germinating in March (Langton 2015, p. 66). DeBeque phacelia seeds do not have the required mechanisms to facilitate horizontal dispersal; therefore, seeds scatter directly beneath the mother plant, known as gravity dispersal, between July and September (Langton 2015, entire). Upon drying, cracks form in the shrink-swell soils this plant prefers, which allow a space for seeds that fall, and upon wet conditions, the cracks close and provide a seed bank. Seeds contained in these seed banks can remain dormant for at least 6 years (Langton 2015, p. 77). DeBeque phacelia requires specific environmental conditions to break seed dormancy; it is currently unknown exactly what those conditions are, but they likely involve a mix of temperature and precipitation. Additionally, DeBeque phacelia uses only self-fertilization for reproduction (Langton 2015, p. 11), which limits its genetic diversity (USFWS, 2024).

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: Numbers of flowering plants fluctuate, but they do not disperse seeds beyond the existing patches of unique soil that are separated from one another by a few yards or several miles (Ewing 2008b, map) (USFWS, 2010).

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Number of Populations:**

26 (USFWS, 2024)

**Population Size:**

10,000 - 100,000 individuals (NatureServe, 2015)

**Additional Population-level Information:**

To discern the nuances in conditions that occur across the range of the species and in the stressors that are influencing these conditions, we analyzed the resiliency, redundancy, and representation of DeBeque phacelia in five analytical units (AUs) (Figure 1). Boundaries for these AUs incorporate all known suitable and occupied habitats and are delineated by natural geological features (e.g., soil type) and a generalization of management boundaries. The 5 AUs are delineated around 26 known element occurrence (EO) areas, as defined by the Colorado Natural Heritage Program (CNHP 2020, entire). EOs are occupied or previously occupied habitat that contributes or potentially contributes to the persistence of the species at a location (CNHP 2020, entire). Our SSA report (Service 2022, entire) includes 25 EOs; however, since completion of the SSA report, we received updated information from CNHP that included an additional EO. Therefore, we are using the current information indicating 26 EOs in this document, and future updates to the SSA report will incorporate this new information. The addition of this newest EO did not change the delineation of the 5 AUs described in the SSA. (USFWS, 2024)

**Population Narrative:**

Vulnerable to changes in habitat conditions, especially surface disturbances such as trampling of soil. An annual species whose population size varies widely from year to year. Because Phacelia submutica is adapted to a very specific geologic substrate and habitat type, a range extension is unlikely. Approximately 35,000-40,000 individuals have been documented within 21 of the 22 occurrences. However, this species is a seed-banking annual with numbers of visible plants varying drastically from year to year. There are 22 principal occurrences documented in the Colorado Natural Heritage Program database. Six of the occurrences have not been observed in over 20 years (as of 2012). The USFS Conservation Assessment documents 40 occurrences (Ladyman 2003). It is likely that this discrepancy in the total number of occurrences is because some of the sites reported by Ladyman are represented in the Heritage database as portions of other occurrences and not reported separately (NatureServe, 2015). Low resileinct, representation and redundancy are based on the low number of known populations, the relatively narrow geographic area this species inhabits and the variability in numbers from year to year. Across its limited range DeBeque phacelia currently has multiple individuals occurring in 25 separate EOs spread across five AUs (Service 2022, pp. 4–5). Redundancy for narrow endemic species is inherently limited; however, DeBeque phacelia plants are distributed broadly across the range of the species in the five defined AUs, providing redundancy throughout its small geographic range, especially given that the only plausible catastrophic event is prolonged extreme drought (Service 2022, p. 33). DeBeque phacelia's broad distribution and multiple moderately resilient AUs contribute to its ability to withstand catastrophic events. Additionally, BLM's ACECs reduce the influence of the stressors of OHV use and oil and gas development in 63 percent of the species' currently occupied range; approximately 359 acres of occupied DeBeque phacelia habitat and nine of the 25 DeBeque phacelia EOs occur within BLM ACECs. A BLM ACEC is a designation that highlights an area where special management attention is needed to protect important historical, cultural, and scenic values, protect fish and wildlife, or protect other natural resources. One of the eight EOs in the South Shale Ridge AU is located in the Pyramid Rock ACEC, which is intended specifically for the preservation of habitat for plant species, including DeBeque phacelia. This area is fenced and closed to livestock use; motorized, mechanized, and equestrian use; and hiking (BLM 2015, p. 31). It is unlikely that any of the ACEC designations will be withdrawn in the foreseeable future (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Oil and gas development (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Increasing oil and gas development in the Piceance Basin is a significant concern in the recovery of the species. About 95 percent of occupied habitat is on BLM lands leased for energy extraction (Service 2012). Ongoing energy development activities include well pad and road construction, installation of pipelines, and construction of associated buildings, holding tanks, and other facilities. Oil and gas pipelines and well pads are present within thirteen EOs (Service 2012). Several pipelines and pipeline right-of-ways already exist within 20 ft (6 m) of DeBeque phacelia EOs (Lincoln 2008, pers. comm.; Service 2012). Roads used for energy extraction bisect and cross the edges of eleven EOs (Service 2012) (USFWS, 2013).

**Stressor:** Utility and Energy Corridors: (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Utility and energy corridors provide pathways for future pipelines and electrical transmission lines. A portion of the designated Westwide Energy Corridor crosses 22,404 ac (9,066.6 ha) of BLM land within the range of DeBeque phacelia (see Figure 3) (Service 2012). Eight of the 20 EOs and 13 percent of critical habitat are within the Westwide Energy Corridor (Service 2012). Continued development of pipeline and transmission lines within the energy corridor is likely to affect DeBeque phacelia and its habitat (USFWS, 2013).

**Stressor:** Livestock Use and Trampling (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Potential threats related to livestock, deer, and elk use include the direct effects from trampling, and the indirect effects of habitat degradation. Ninety percent of DeBeque phacelia EOs are under management by the BLM as a grazing allotment (Service 2011a). Livestock trampling has occurred or is a threat at 14 EOs (CNHP 2010). Livestock can easily trespass from BLM or private grazing allotments onto USFS property where grazing is not allowed. This has been documented at two occurrences, one obtaining frequent disturbance from its proximity to a pond (Langton 2012). No research or monitoring has been conducted to evaluate the effects of livestock, deer, or elk use on DeBeque phacelia. However, the deleterious effects of livestock on western arid ecosystems are well documented (Milchunas et al. 1992; Jones 2000). Some of the adverse effects from livestock include changes in water infiltration due to soil compaction (Jones 2000, Table 1); changes to the physical and structural properties of soils (Kinlock and Friedel 2002); disturbance to soil microbiotic crusts (Evans and Belnap 1999; Jones 2000); subsequent nonnative invasive plant invasions (Parker et al. 2006); and soil erosion from hoof action (Jones 2000). Effects from livestock grazing to DeBeque phacelia and its habitat are occurring will likely continue (USFWS, 2013)

**Stressor:** Off-Highway Vehicle Use (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Off-highway-vehicle (OHV) use occurs on lands throughout the range of DeBeque phacelia. OHV recreation has damaged plants and habitat at seven EOs (CNHP 2012). On Federal lands, vehicles stray from designated roads to climb clay barrens for recreational purposes (Johnston 2012; Mayo 2008d). OHV trespass has even been documented within the Pyramid Rock Natural Area and BLM Area of Critical Environmental Concern (ACEC). The ACEC is fenced with post and cable, and an information sign is posted near an access point. The visible effects of OHV recreation within DeBeque phacelia habitat has been seen to persist for several years (Johnston 2012). Surface disturbances from OHV recreation cause accelerated erosion, fugitive dust production, soil compaction, sedimentation, and potentially irreversible changes to soil physical properties and chemistry (Iverson et al. 1981; Pagliali et al. 2003). Additionally, these changes in the soil environment can affect ecosystem function (DeFalco 2009. OHV use is expected to increase in the region with the construction of additional roadways for energy development and the increasing popularity of OHV recreation. With OHV recreation within the range of the species, direct losses of plants and the seed bank, as well as indirect affects to the species and its habitat will continue to occur (USFWS, 2013).

**Stressor:** Invasive Nonnative Plants (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The threat from invasive nonnative plant species (weeds) is a growing concern in the recovery of DeBeque phacelia. Weeds have been documented at 15 EOs (CNHP 2012a). Disturbances such as roads, grading, and livestock grazing generally introduce and spread exotic species (Gelbard and Belnap 2003). Weeds invade and alter all types of plant communities, sometimes resulting in nonnative plant monocultures that support little wildlife or native plants (D’Antonio and Vitousek 1992; Olson 1999; Mooney and Cleland 2001). Many experts believe that, following habitat destruction, nonnative invasive plants are the next greatest threat to biodiversity (Randall 1996). Nonnative invasive plants alter different ecosystem attributes including geomorphology, fire regime, hydrology, microclimate, nutrient cycling, and productivity (Dukes and Mooney 2004). Species known to occur within DeBeque phacelia habitat include cheatgrass (Bromus tectorum), bur buttercup (Ranunculus testiculatus), and annual wheatgrass (Eremopyrum triticeum). These weeds are prevalent on public and private lands within the range of the DeBeque phacelia. Recent data suggest that weed cover in DeBeque phacelia sites is related to distance from roads, while the number of flowers was found to be higher at distances away from roads (BioLogic 2011). The control of weeds on public lands, especially around well pads, utility corridors, and roads, may also pose a danger to DeBeque phacelia. For example, herbicide drift from well pad spraying has led to the mortality of Colorado hookless cacti near DeBeque (Perkins 2012, pers. comm.) (USFWS, 2013).

**Stressor:** Water Reservoirs (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat

**Narrative:** Two water reservoir projects known as Roan Creek and Sulphur Gulch were proposed within potential and occupied habitat of DeBeque phacelia (Bray and Drager 2008, pers. comm.; Grand River Consulting Corporation 2009). The proposals were withdrawn and are not imminent. However, the sites have been identified as potential reservoir locations that could be developed within 20 years if warranted by increased demands for water. Increased demands are likely, depending on the oil shale market, urban development in Colorado, and less (or altered) precipitation due to climate change. If developed, construction and inundation of these reservoirs would permanently destroy DeBeque phacelia plants and habitat within the project areas (USFWS, 2013).

**Stressor:** The Inadequacy of Existing Regulatory Mechanisms (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** Removal, damage, or destruction of plants on private lands is not prohibited under the Endangered Species Act (Act). We are not aware of any state, county, city, or local laws, ordinances or zoning that provide for the protection or conservation of DeBeque phacelia or its habitat. Though no state regulations protect rare plants in Colorado, the Colorado Natural Areas Program manages a State Natural Area on BLM land protecting 510.9 ac (206.7 ha) of the species' habitat within the Pyramid Rock population. This agreement between Colorado Natural Areas Program and the BLM can; however, be terminated with a 90-day written notice by either party. Additional habitat on state land includes 7.5 ac (3 ha) of the Anderson Gulch population. This population contains the only "A"- ranked Elemental Occurrence (CNHP 2012a) meaning it has excellent estimated viability/ecological integrity. The majority of this population (90 percent) is within the Piceance Creek State Wildlife Area and is managed by Colorado Parks and Wildlife (USFWS, 2013).

**Stressor:** Climate Change and Drought (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** According to the Intergovernmental Panel on Climate Change (IPCC), "Warming of the climate system in recent decades is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level" (IPCC 2007). Research indicates that warming is occurring more rapidly in the southwest region of the United States that elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Additionally in the west, the onset of spring has been advancing since the 1970's (Cayan et al. 2001). Annual temperature is predicted to increase approximately 2.2°C (4°F) in the southwest by 2050, with summers warming more than winters (Ray et al. 2008). Effects of climate change include persistent or prolonged drought conditions, changes in the vegetative community including increased invasions by weeds (Everard et al. 2010). Climate change is likely to affect many rare plant species because seed germination, seed dormancy, and persistence of the seed bank are all directly dependent on precipitation and temperature patterns (Levine et al. 2008). However, we do not understand how these changes may affect the long-term persistence of DeBeque phacelia because no information is available on the ecology of the species. Improved localized projections and precipitation models are also needed to better understand the threat of climate change to the species. The potential impacts of climate change will be significant at a global scale and we expect the predicted increased

drought conditions to affect the recovery of DeBeque phacelia (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
The preliminary plan lists three basic steps for recovery: 1: Protect and maintain all extant populations (USFWS, 2013).

2. Prevent of minimize habitat disturbing threats (USFWS, 2013).

Develop and implement rangewide monitoring (USFWS, 2013).

Recovery Priority Number: 14C

**Delisting Criteria:**
Recovery Criterion 1: Presence of DeBeque phacelia is maintained within at least 20 EOs across 5 analytical units (AUs). (USFWS, 2024).

Recovery Criterion 2: In at least 13 EOs, the number of aboveground plants remains at or above 500 individuals during years where aboveground growth is observed at known occurrences of DeBeque phacelia over a 15-year period. (USFWS, 2024)

Recovery Criterion 3: Maintain habitat quality, as measured by low (less than 20 percent) vegetative cover and high soil functional integrity, within known occupied habitat for DeBeque phacelia across all 5 analytical units (AUs) over a 15-year period. (USFWS, 2024)

Recovery Criterion 4: Maintain or improve existing regulatory mechanisms and associated protective measures for the 9 EOs within currently designated ACECs. For EOs on Federal lands outside of these ACECs, new or amended land management designations may include adequate protective measures for DeBeque phacelia and its habitat to reduce or ameliorate threats associated with soil disturbance and non-native, invasive plant species. On lands outside of Federal management, additional protective measures may include formal land management designations, management agreements, conservation agreements, easements, or other conservation plans or mechanisms. (USFWS, 2024)

Recovery Criterion 5: All AUs are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004, entire). The ex-situ seed collection should contain existing levels of genetic diversity (representation) of DeBeque phacelia across the species' range. (USFWS, 2024)

**Recovery Actions:**
- Protection of Extant Populations and Habitat: Establish and implement protective measures for all known populations (USFWS, 2013).
- Threats Abatement: Implement protective measures such as fencing, controlled management of livestock use, nonnative species control and additional measures to avoid or minimize impacts to the species and its habitat (USFWS, 2013).
- Threats Abatement: Coordinate with land managers, project proponents, and other partners early in the planning process to limit direct and indirect effects of oil and gas development,

grazing, OHV recreation, weeds, and additional threats that arise (USFWS, 2013).

- Threats Abatement: Work with land management agencies and other partners to formally establish land management designations to provide for long-term protection of populations and habitat (USFWS, 2013).
- Threats Abatement: Ensure that additional oil and gas leases avoid or take into consideration occupied and suitable habitat (USFWS, 2013).
- Threats Abatement: Consider installing livestock exclosures for both protection and monitoring purposes (USFWS, 2013).
- Surveys and Monitoring: Complete a comprehensive survey throughout the species' range, including areas designated as "potential habitat". Survey results should provide an accurate population estimate and allow us to identify core population areas so we can more effectively protect the species (USFWS, 2013).
- Surveys and Monitoring: Establish a survey protocol to identify areas of suitable habitat during years in which few above-ground plants are found. This protocol must take into account an evaluation of habitat components that support DeBeque phacelia (USFWS, 2013).
- Surveys and Monitoring: Establish a long-term monitoring plan to document rangewide population demographics and trends, and quantify the affects from threats. An adaptive management approach that uses feedback from implemented, site-specific recovery tasks should be integrated into the plan to inform recovery activities (USFWS, 2013).
- Surveys and Monitoring: Gain permission from landowners to survey for DeBeque phacelia on private lands with potential habitat (USFWS, 2013).
- Research: Continue research into DeBeque phacelia life history and ecology, including pollination biology, seed bank density, seed bank longevity, seed germination ecology, and habitat and soil requirements (USFWS< 2013).
- Research: Study population genetics and demographics (USFWS, 2013).
- Research: Conduct a population viability analysis (USFWS, 2013).
- Research: Conduct investigations that project DeBeque phacelia vulnerability and response to climate change (USFWS, 2013).
- Research: Improve our understanding of livestock and native ungulate grazing impacts (USFWS, 2013).
- Research: Monitor changes in invasive species prevalence and conduct research on impacts to DeBeque phacelia (USFWS, 2013).
- Research: Continue to refine a survey protocol for delineating suitable habitat (USFWS, 2013).
- Research: Continue to analyze the effects of dispersed oil and gas development and roads (USFWS, 2013).
- Seed Banking: Store genetic material in the form of seed in an appropriate repository to provide a back-up supply of genetic stock that represents as much of the available genetic diversity within the species as possible (USFWS, 2013).
- Priority 1 Actions: 1. Conduct primary research to fill information gaps on DeBeque phacelia ecology and inform development of monitoring methods (Criteria 1, 2, 3, and 4). 2. Develop standardized methodology for data collection and analysis to monitor all DeBeque phacelia EOs across all 5 AUs (Criteria 1, 2, 3, and 4). 3. Maintain or augment all extant DeBeque phacelia populations (EOs) on Federal and State lands in all five AUs (Criteria 1, 2, 3, and 4). 4. Develop ex-situ (off-site) collections of seeds to preserve DeBeque phacelia genetic diversity (representation) and provide the capability to augment existing populations, if

necessary (Criterion 5). (USFWS, 2024)

- Priority 2 Actions: 5. Survey for additional populations of DeBeque phacelia (Criteria 1 and 2). (USFWS, 2024)
- Priority 3 Actions: 6. If there is a population decline or loss (e.g., based on the results of Recovery Actions 1 and 2), develop and implement a range-wide strategy for population augmentation, or if necessary, re-introductions (Criteria 1, 2, and 3). (USFWS, 2024)

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# SPECIES ACCOUNT: *Phlox hirsuta* (Yreka phlox)

***Species Taxonomic and Listing Information***

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

**Physical Description**

Cespitose perennial subshrub from a stout, woody base. Stems stout, to 1.5dm tall. Herbage copiously hirsute with long, jointed hairs. Leaves crowded Blooms April-June. (NatureServe, 2015)

**Taxonomy**

Elias Nelson (1899) described P. hirsuta based on a collection made by Edward L. Greene in 1876. A complete nomenclatural history can be found in Appendix 1 of the Recovery Plan for Phlox hirsuta (Yreka Phlox) (U.S. Fish and Wildlife Service 2006). No changes in taxonomy have occurred since the time of listing (USFWS, 2007).

**Historical Range**

Phlox hirsuta is known to occur at five locations, which are referred to as the “China Hill,” “Soap Creek Ridge,” “Cracker Gulch,” “Greenhorn Creek,” and “Jackson Street” occurrences. In addition, the locality information from a single 1930 collection indicates a possible historical location in the vicinity of Etna or in the vicinity of Echo Mill, near Soap Creek Ridge (California Department of Fish and Game 1986; J. Molter in litt. 2001; Appendix 1, prepared by F. Lang in U.S. Fish and Wildlife Service 2006). A P. hirsuta location or occurrence is defined as a group of at least 200 individual plants that is separated from any other P. hirsuta locality by at least 0.40 kilometer (0.25 mile). (USFWS, 2007)

**Current Range**

In and near the towns of Yreka and Etna in Siskiyou County, northern California (USFWS 1995). Range extent is approximately 34 sq mi. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

***Dispersal/Migration***

***Population Information and Trends***

***Threats and Stressors***

***Recovery***

**Reclassification Criteria:**

Recovery Priority Number: 2C

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future actions will focus on securing and permanently protecting four (up to six) Yreka phlox occurrences and ameliorating ongoing threats of invasive weeds. Work has been initiated on each of the actions listed below. • Funding is needed to purchase, or establish conservation easements on, Cracker Gulch, the northern portion of Soap Creek Ridge, and Greenhorn Creek Occurrence properties from willing sellers who have indicated their strong interest in conserving Yreka phlox habitat in perpetuity. • Complete the cooperative agreement with the Siskiyou Land Trust to approach Greenhorn Creek property owners who might wish to establish conservation agreements or easements on several additional scattered properties where Yreka phlox occurs. • Continue to cooperate with the City of Yreka and the County to protect populations from off-road vehicle trespass and invasive non-native weed infestation. • Collect and accession seeds from each Yreka phlox occurrence at the Rae Selling Berry Seed Bank and California Botanic Garden. • Consult, through section 7 of the Endangered Species Act, with the Klamath National Forest on the effects to Yreka phlox of the 2022 McKinney Fire suppression actions, especially with respect to the introduction of non-native invasive weeds on contingency fire lines (USFWS, 2024).

**References**

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# SPECIES ACCOUNT: *Phlox nivalis ssp. texensis* (Texas trailing phlox)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/30/1991; Southwest Region (Region 2) (USFWS, 2016)

**Physical Description**

The Texas trailing phlox is an evergreen perennial that forms clumps (but seldom mats). The plants are herbaceous or subshruby. Stems tend to spread along the ground surface, and are erect only for the terminal 2—15 centimeters (0.8-5.9 in). Leaves are needlelike to lanceolate, densely packed on the stem (producing an appearance somewhat like a juniper seedling), usually less than 1.5 cm (0.6 inch) long, and more or less glandular pubescent. Older stems have smaller and darker green leaves, and typically lie directly on the ground surface. Young stems produce the flowers, are more or less erect, and have longer, slightly wider, and lighter—green leaves. Inflorescences are 3-12 flowered cymes, terminal on (typically) the tallest stems. The calyx is tubular with five sepals, which are fused for most of their length. The corolla is rotate, with a tube approximately 1.5 centimeters (0.6 inch) long. The five petals, each about 1 centimeter (0.4 inch) long, are pink to magenta in color, and darker near the throat. Petals are reported to be white in some individuals. Pistils have three styles, and the ovule is usually single. Fruits are achene— like, and apparently indehiscent (this character description of the fruit differs from previously published summaries). Flowering occurs from March to May. (USFWS, 1994)

**Taxonomy**

Texas trailing phlox belongs to the family Polemoniaceae, which includes such plants as sweet William, Jacob's ladder, Texas plume, and phlox. Texas trailing phlox is one of two subspecies recognized in P. nivalis. The nominal subspecies (ssp. nivalis) occurs in pine/oak barrens or scrub on the Coastal Plain or Piedmont, from Alabama to Florida and north to Virginia. Flowers of this subspecies are typically white or pale pink, with plants of forma roseiflora having deep rose or magenta flowers (Fernald 1970). According to Wherry (1955), the major difference between the two subspecies is the presence of minute glandular hairs on texensis, and their absence on nivalis. Currently, the nearest known populations of ssp. nivalis to those of texensis are located more than 1000 kilometers (600 miles) eastward in northern Florida. Wherry included Phlox nivalis in series Subulatae, along with Phlox subulata and Phlox oklahomensis. Both of the latter species have gross morphological features similar to that of P. nivalis, but Bogler (1992) expressed the opinion that, based on Texas specimens, fl. nivalis is most similar to P. oklahomensis. Populations of P. oklahomensis found in Texas are disjunct from the main range of P. oklahomensis (located further north in Oklahoma), lying approximately equidistant between it and range of P. nivalis ssp. texensis. (USFWS, 1994)

**Historical Range**

Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas. (USFWS, 1994)

**Current Range**

Endemic to the Pineywoods of the West Gulf Coastal Plain of east Texas. Texas trailing phlox is presently known from only two sites, one each in Tyler and Hardin counties, Texas. (USFWS, 1994; NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (vegetative) and sexual (outcrossing) (USFWS, 1994)

**Breeding Season**

Adult: Flowering generally occurs between late March and early April (Ajilvsgi 1979, Poole et al. 2007, U.S. National Park Service (USNPS) 2015), sometimes extending into May depending on precipitation and management (i.e. prescribed burning). (USFWS, 2018)

**Other Reproductive Information**

Adult: Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. (USFWS, 1994)

**Reproduction Narrative**

Adult: Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. Typically, no more than one seed is produced per flower and, based on limited field observation, fruit set is low. An individual plant may have 3 to 50+ flowers and primarily depending on number of flowers. Its low population numbers are likely due to a combination of anthropogenic factors and a naturally low reproductive rate. (USFWS, 1994); Little is known about the reproduction of the Texas trailing phlox. Their populations are small and consist of a few scattered, inconspicuous individuals (Mahler 1980). This could make asexual reproduction very important for recruitment (Parker and Warnock 1993) but this frequency is unknown. Texas trailing phlox is mostly an outcrossing species pollinated by moths and butterflies (Bogler 1992). However, it is not known whether flowers are obligate or facultative outcrossers (Maxey and Warnock 1996, USFWS 1995). Pollinators include carpenter bees (M. Quinn, pers. comm. 2008), Nessus sphinx moth (Amphion floridensis) (G. Grant, pers. comm. 2017), and Tiger swallowtail butterfly (Papilio glaucus) (G. Grant, pers. comm. 2014). Other bees and butterflies, as well as flies could also serve as pollinators (USFWS 1995, Maxey and Warnock 1996, TPWD 1997). Poole et al. (2000) noted that there is the potential of large terrestrial arthropods to act as pollinators. Also, seed and seedling biology (seed maturation, dormancy, seed viability) are largely unknown for the Texas trailing phlox. We lack information about seed dispersal; however, dehiscence could play a role in local dispersal. (USFWS, 2018)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

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

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Texas trailing phlox occurs in southeast Texas in the southern portion of the Pineywoods vegetational area. Within the range of Texas trailing phlox, annual precipitation averages 125 cm (49 in), with no pronounced summer drought. The average frost—free period is 244 days (Bogler 1992), from early March through mid-December (Larkin and Bomar 1983). Elevation ranges from 9 to 75 meters (30-240 feet), and topography is nearly level. This species prefers deep, sandy soils in fire-maintained openings in upland longleaf pine (Pinus palustris) savannahs or post oak-bluejack oak (Quercus stellata-Q. incana) woodlands. Field studies suggest that sandy surface soil, coupled with moisture-bearing clays or sandy-clay soils at depths of 0.5-2 meters (1.6-6.6 feet), provide the best soil structure for Texas trailing phlox. Overstory cover at sites of Texas trailing phlox occurrence typically ranges from 25-75 percent. Understory and shrub cover is less than 25 percent at most plant sites, but ranges up to nearly 100 percent at some. However, the best growth of Texas trailing phlox is seen at the lower percentages of understory and shrub cover. The degree of ground cover associated with optimum growth of Texas trailing phlox appears to be 25-75 percent. Litter depth is generally 3-5 cm (1.2-2.0 in), and coverage is usually 75-100 percent. The most common canopy trees associated with Texas trailing phlox are Pinus palustris, P. elliottii, R. taeda, Ouercus incana, Q. falcata, and Q. stellata and Carva texana. (USFWS, 1994; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Long-term trends indicate a decline of 30 to 70%, whereas short-term trends suggest a relatively stable population (NatureServe, 2015)

**Resiliency:**

Populations were considered to have high resiliency when they: contained at least 600 individuals, exhibited plant separation less than 2 kilometers (1.24 miles), contained canopy cover between 5-25 percent, limited shrub layer cover to 10-25 percent, maintained litter depths of 3-5 centimeters, and received an annual precipitation rate of 48-60 inches (121.9-152.4 centimeters). Frequent fire exposure (every 1-2 years) serves as a critical component to sustaining healthy individual plants within the longleaf pine ecosystem, as well as other native vegetation associated with the Pineywoods. Using all of these factors, seven extant populations were ranked either low or moderate in current resiliency (USFWS, 2020).

**Representation:**

We lacked genetic studies specific to Texas trailing phlox examining variability within and among its' populations. Further genetic analysis of Texas trailing phlox could determine to what extent, if any, the impact of range contraction contributes to the loss of the genetic variability. Due to an absence of genetic information informing our measure of representation, we used ecological diversity as a surrogate for genetic diversity. We assumed no ecological or niche diversity at any of the specific sites therefore, the representation of Texas trailing phlox is extremely low (USFWS, 2020).

**Redundancy:**

For the Texas trailing phlox, we measured redundancy as an adequate number of resilient populations that provided an exchange of genetic material and foraging opportunities for pollinators. Due to the low or moderate resilience rankings of most populations, the few number of extant populations, and that these populations are distributed throughout a restricted range, we estimated that both connectivity for pollinating species and exchange of genetic material is limited. Therefore, we rank the overall redundancy of Texas trailing phlox as low (USFWS, 2020)

**Number of Populations:**

7 (USFWS, 2018)

**Population Size:**

<750 individuals (NatureServe, 2015)

**Population Narrative:**

Long-term trends indicate a decline of 30 to 70%, whereas short-term trends suggest a relatively stable population. Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas. Although nineteen collections of Texas trailing phlox are reported in historical records, these appear to originate from only six definable population systems, however, only two are extant populations. Reintroductions are being attempted in areas where there were historic populations. (NatureServe, 2015); When the species was listed as endangered in 1995, there were only 2 known populations in southeast Texas, one in Hardin County (the type locality) and another from Tyler County. Since then, 17 populations were observed in Hardin, Polk, and Tyler counties, however, these are considered extirpated. The USFWS Recovery Plan (1995) provides a definition of a “population” and a “plant”. Based on this definition, the USFWS recognizes that there are 7 known extant populations in Hardin, Polk, and Tyler counties that include: 1) Sunflower road (Element of Occurrence (EO) 17) and Big Thicket National Preserve (BTNP), Big Sandy Creek reintroduction; 2) Farm-to-Market 1276 right-of-way (EO 21); 3) Campbell Units (EO 22 and 23); 4) The Nature Conservancy, Roy E. Larsen Sandylands Sanctuary (EOs 3, 5, 13); 5) Resource Management Services (EO 9); 6) Hancock Timber (introduced); and 7) BTNP, Turkey Creek reintroduction. Land ownership includes private, public, and state lands. (USFWS, 2018). These extant EO ID’s remain owned and managed by TNC Sanctuary staff. The EO ID was last surveyed for Texas trailing phlox in 2023. Prior to that, the Sanctuary staff conducted a thorough assessment of extant populations in 2019, surveying 68 sites (61 previously recorded and 7 new sites) counting 304 plants (W. Ledbetter, pers. comm. 2019). Dr. C. Edwards and Dr. G. Yatskievych conducted a thorough genetic analysis of the Texas trailing phlox (Edwards 2022, entire) which included sampling from known Sanctuary plants. More information about their research is detailed in the Conservation Measures section of this review. Edwards, Yatskievych, TNC, and the Service visited these EO ID’s between March 30 and April 1, 2021, and found 300+ individual plants (S. Benedict, pers. comm. 2021) at 31 global positioning position (GPS) locations (Strong 2023, redacted site info excel sheet). A site assessment was not completed in 2022; however, in April and May of 2023, TNC staff counted 255 plants across the management units (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat loss (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss has been caused by housing development; land—clearing and site preparation for pine plantations and pasture; encroachment of a closed canopy forest onto formerly open forest or savanna due to fire suppression; exposure to herbicides; and activities associated with pipeline, powerline, railroad, and highway construction. (USFWS, 1994)

**Stressor:** Human activities (USFWS, 1994; NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Factors adversely affecting the habitat of Texas trailing phlox, combined with other potentially adverse activities such as off-road vehicle use, illegal dumping, burning of debris, and commercial take of plants, may continue to restrict the species to critically low population levels. Current threats include continued habitat loss due to canopy closure/encroachment of hardwood trees and soil disturbances associated with human activities. (USFWS, 1994; NatureServe, 2015)

**Stressor:** Clearcuts (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Much of this taxon's habitat had been clearcut and converted to slash-pine plantations, urbanized, and/or altered by fire suppression. (NatureServe, 2015)

***Recovery***

**Reclassification Criteria:**
1. At least 12 self-sustaining populations, distributed across the known geographic range of Hardin, Polk, and Tyler counties, Texas, are established. There should be at least three populations located in each county in order to provide adequate representation. The remaining three populations can be distributed in any fashion among the available habitat across the geographic range. A population will be considered self-sustaining if it reaches and maintains a population number of at least 600 reproductive individual plants. A population is considered a group of plants separated by a distance of at least 2 kilometers (km) (1.2 miles (mi)) from any other Texas trailing phlox plants, as to promote healthy populations of pollinators and the exchange of genetic material. A “plant” is defined as a cluster of Texas trailing phlox stems with no above-ground connection to other groups of stems, and separated by a distance of at least 5 decimeters (dm) (1.6 feet (ft)). Habitat will be of sufficient quality as defined by Maxey and Warnock (1996), that it promotes the success of Texas trailing phlox. The numbers of plants and populations must be verified through adequate monitoring. Populations can include both natural and ex-situ (introduction and reintroduction) efforts. To be considered under this criterion, the habitats of Texas trailing phlox must be managed in a manner that promotes the

continued survival of the subspecies. Management can include, but is not limited to, prescribed burning and/or restoration of longleaf pine habitat. (USFWS, 2019)

2. Sufficient, documented protection measures and management plans have been established for these 12 self-sustaining populations. Long-term, binding agreements that aim to conserve and protect the subspecies, and its habitat, are preferred. Private lands should be a priority focus for these agreements; however, protected areas can and should include lands owned by federal, state, or local government agencies. (USFWS, 2019)

Recovery Priority Number: 3

**Delisting Criteria:**
1. To secure redundancy of the subspecies into the foreseeable future, we conclude that more populations would be needed for delisting. Therefore, at least 15 populations distributed across the known geographic range of Hardin, Polk, and Tyler counties, Texas, have been established. At least four populations should be located in each of the counties in order to provide representation of the potential genetic and ecological diversity of the subspecies. The remaining three populations can be distributed in any fashion among the available habitat within the range. A population will be considered self-sustaining if it reaches and maintains a population number of at least 600 reproductive individual plants. Ex-situ efforts should be focused within the known geographic range unless habitat suitability mapping proves otherwise. Habitat will be of sufficient quality, as defined by Maxey and Warnock (1996), that it promotes the success of Texas trailing phlox. (USFWS, 2019)

2. Monitoring efforts indicate that the MVP level of 600 reproductive plants at each population has remained stable or has increased over a monitoring time period of 30 years. Monitoring must be routine in order to gauge subspecies' viability. Site-specific management plans should be aligned with landscape scale strategies to attain optimal habitat quality conditions that promotes the Texas trailing phlox. (USFWS, 2019)

**Recovery Actions:**
- Monitor, protect, and manage existing populations. (USFWS, 1994)
- Locate or establish additional populations of sufficient number to meet downlisting criteria. (USFWS, 1994)
- Obtain biological data necessary to refine downlisting criteria. (USFWS, 1994)
- Characterize suitable habitat of plant and determine the management regime needed to preserve suitable habitat. (USFWS, 1994)
- Determine limiting factors on reproduction. (USFWS, 1994)
- Establish captive populations to protect genetic integrity. (USFWS, 1994)
- 1) Conduct Genetics Investigations: Conduct studies to determine genetic diversity of the Texas trailing phlox. Conduct studies to determine the genetic relatedness between individual plants within a population. Determine relatedness between populations across the species geographic range. Determine the relationship between Texas trailing phlox plants to Phlox oklahomensis, found in Texas, and to Phlox nivalis, found in Louisiana. Use this new genetic information to re-evaluate the criteria used in the Texas trailing phlox Recovery Plan to define a population and an individual plant. (USFWS, 2018)

- 2) Promote Landowner Stewardship and Outreach: Encourage awareness of Texas trailing phlox, its management needs within longleaf pine savanna habitat, and its habitat structure/composition. Develop outreach resources for landowners and land managers. Provide technical support for management, surveys, monitoring, and conservation efforts. Provide financial support for management and/or leverage funds for restoration and recovery efforts. (USFWS, 2018)
- 3) Monitor Extant Populations: Continue to monitor extant populations of Texas trailing phlox to assess species viability, habitat conditions, and management needs. Continue management on sites and acquire long-term conservation easements, where feasible, or conservation agreements. (USFWS, 2018)
- 4) Survey for New Populations: Develop a habitat suitability map to assist in identifying new parcels of land for surveying, restoration, and ex-situ opportunities. Outreach to new landowners and land managers. Conduct surveys of potential Texas trailing phlox habitat, with landowner permission, throughout species' known geographic range. (USFWS, 2018)
- 5) Revisit Historic Populations: Use herbarium records, field data, and expert input to determine and revisit sites presumed to be extirpated. Coordinate with landowners and land managers to access sites. Educate landowners and land managers about the Texas trailing phlox and its habitat. Conduct surveys of suitable areas with permission. Submit data to TPWD's Texas Natural Diversity Database. (USFWS, 2018)
- 6) Actively Manage Habitat: Develop management plans with landowners and land managers with the primary goal of restoring or maintaining longleaf pine savanna habitat for Texas trailing phlox. Investigate plant response to management practices (prescribed burning, mowing, thinning), conducted in various frequency and intensity schemes. (USFWS, 2018)
- 7) Develop Reintroduction Plan: Develop a Controlled Propagation and Reintroduction Plan (per USFWS policy). Limit reintroduction work to the known geographic range of the species (Hardin, Tyler, Polk counties). Coordinate with the Center for Plant Conservation Institutions' guidelines for augmentation procedures. (USFWS, 2018)
- 8) Conduct Essential Life History Studies: Investigate pollinating species of Texas trailing phlox and promote pollinator conservation. Conduct seed biology (seed maturation, fecundity, seedbank) and seedling studies (longevity of plant, mortality). Encourage collaboration, ingenuity, financial support, and technical support between partners and the USFWS to conduct these studies. (USFWS, 2018)
- Conservation measures are not available.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Future actions to aid in the recovery of the Texas trailing phlox should focus on implementation of the following recovery actions: 1.2 Provide immediate protection for existing habitat areas. Most of the extant populations outside of the TNC Sanctuary are declining in abundance and most are on private lands. Long-term mechanisms such as cooperative agreements for conserving and protecting genetically important populations is essential and should be explored with landowners and land managers. 1.3 Contact landowners and land managers of all Texas trailing phlox sites. Changes in landowner/land managers at several of the sites, many of which are privately owned, have occurred. Contact with the new owners at the Tyler County reintroduction site were made in June 2023 and a potential site visit was discussed for fall 2023. Each land steward should be made aware of the ecologic and genetic importance of the Texas trailing phlox. The Service should seek out opportunities to build and strengthen relationships with new land stewards and continue to work with and foster existing partnerships. 1.4 Work with landowners to develop and implement compatible management for Texas trailing phlox. Assist and/or develop management plans with land stewards with the primary goal of restoring and maintaining longleaf pine savanna habitat for the species. Investigate plant response to management practices (prescribed burning, mowing, thinning), conducted in various frequency and intensity schemes. Encourage collaboration, ingenuity, and financial and technical support between partners and the Service to conduct on the ground management and track the response of these management actions. 1.4.3. Continue to seek landowner assistance with monitoring activities. Continue to actively engage with land stewards at extant sites to monitor and understand conservation needs. Verifying the status of the EO ID records considered to be unverified or historic are a priority. 1.5 Monitor Extant Populations. Continue to monitor extant populations, assessing species' viability, habitat conditions, management needs, and potential threats. 2.1 Search for new populations in suitable East Texas habitat. Develop a habitat suitability map to assist in identifying new parcels of land appropriate for surveying, restoration, and ex-situ opportunities. Using updated habitat suitability mapping and information, the Service should seek out and conduct searches for additional populations of Texas trailing phlox across its range. 3. Implement captive propagation program. Ensure collection of seed and/or plant material from populations where threats remain high, abundance is low, and/or genetic analysis suggested distinctiveness. Work with local Center for Plant Conservation partner to follow collection and storing procedures. 5. Investigate the reproductive biology of Texas trailing phlox including pollination (5.2) seed biology (5.3), and seedling studies (5.5). Conduct essential life history studies, but not limited to the abovementioned topics, should new biological needs arise for the species. Encourage collaboration between the Service, partners, and land stewards to foster ingenuity, financial and technical support to conduct such studies. 6. Investigate the response of Texas trailing phlox to various management techniques and types of disturbance. Assist in the development and implementation of studies aimed at investigating plant response to different types of management, conducted in various seasons, frequency, and intensity. Provide updates to land stewards and partners to better manage the Texas trailing phlox and its habitat throughout the range. Ensure that findings are made available to the public and other potential managers of longleaf pine savanna habitats. 8. Develop Reintroduction Plan. Develop a Controlled Propagation and Reintroduction Plan (per USFWS policy). Limit reintroduction work to the known geographic range of the species (Hardin, Tyler, Polk counties). 9. Implement public education efforts. Encourage awareness of Texas trailing phlox, its management needs within the longleaf pine savanna habitat, and its habitat structure/composition. Develop outreach resources for land stewards. Provide technical support for management, surveys, monitoring, and conservation efforts. Provide financial support for management and/or leverage funds for restoration and recovery efforts (USFWS, 2023).

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# SPECIES ACCOUNT: *Physaria douglasii ssp. tuplashensis* (White Bluffs bladderpod)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 05/23/2013; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

White Bluffs bladderpod is a low growing, herbaceous, perennial plant with a sturdy tap root and a dense rosette of broad gray-green pubescent leaves (WDNR 2010). The subspecies produces showy yellow flowers (USFWS, 2013a).

**Taxonomy**

Although specimens of this taxon were originally collected from a population in 1883, the plant material was in poor condition, no definitive identification could be made, and the plant was not recognized as a species at that time. The population was rediscovered in 1994, and was described and published as a species, Lesquerella tuplashensis, by Rollins et al. (1996, pp. 319–322). Based on molecular, morphological, phenological, reproductive, and ecological data, the conclusions in AlShehbaz and O'Kane (2002, p. 322) and Caplow et al. (2006, pp. 8–10) combining the genera Lesquerella and Physaria and reducing the species Lesquerella tuplashensis to Physaria douglasii subsp. tuplashensis, provide the most consistent and compelling information available to date (USFWS, 2013a).

**Historical Range**

In 1996, White Bluffs bladderpod was only known from a single population that occurred along the upper edge of the White Bluffs of the Columbia River in Franklin County, Washington (USFWS, 2013a). It is endemic to a small band about 17 km long by about 10 meters wide (NatureServe, 2015).

**Current Range**

White Bluffs bladderpod is still known only from the single population that occurs along the upper edge of the White Bluffs of the Columbia River, Franklin County, Washington (USFWS, 2013a). Extensive searches of suitable substrate elsewhere in Washington have been conducted but no other plants have been found (USFWS, 2004; NatureServe, 2015). – In the late 1990s the subspecies was described as occupying a narrow area 17 to 20-km long on the slopes and top of the White Bluffs. When the listing rule was revised, it was determined that the occupied area had likely shrunk due to threats and habitat changes in the southern part of the range (USFWS 2013b, p. 76998). The recent and current range of White Bluffs bladderpod is uncertain because there has not been a complete survey since 1997, only the northern part of the distribution is monitored. The northern part continues to be occupied but the status of the southern part is unknown. However, Refuges' outplanting efforts from 2013 to 2015 have resulted in at least a temporary range expansion within the Monument. As of 2020, the plants in the outplanting area were still successfully reproducing. The establishment of a self-sustaining population there could be essential to the continuation of the subspecies should there be catastrophic landslides where the main population occurs. (USFWS, 2020)

**Critical Habitat Designated**

Yes; 4/23/2013.

**Legal Description**

On April 23, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Physaria douglasii ssp. tuplashensis (White Bluffs bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (78 FR 76995-77005; 78 FR 24008-24032).

**Critical Habitat Designation**

The critical habitat designation for Physaria douglasii ssp. tuplashensis includes one CHU in Franklin County, Washington. This species critical habitat encompasses approximately 2,033.4 acres (ac) (822.9 hectares (ha)) (78 FR 76995-77005; 78 FR 24008-24032).

White Bluffs bladderpod is only known from a single population that occurs in a narrow band approximately 10 m (33 ft) wide by 17 km (10.6 mi) long, at the upper edge of the White Bluffs of the Hanford Reach. The subspecies only occurs at the upper surface areas of a near-vertical exposure of paleosol (ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in an area). This surface material overlies several hundred feet of easily eroded sediments of the Ringold Geologic Formation, a sedimentary formation made up of soft Pleistocene lacustrine deposits of clay, gravel, sand, and silt (Newcomb 1958, p. 328). The upper part of the Ringold Formation is a heavily calcified and silicified cap layer that exists to a depth of at least 4.6 m (15 ft). This layer is geologically referred to as ‘‘caliche,’’ although it lacks the nitrate constituents found in true caliche. The caliche-like layer is a resistant caprock underlying a 275–305 m (900–1,000 ft) plateau extending north and east from the White Bluffs (Newcomb 1958, p. 330). The entire population of White Bluffs bladderpod is down-slope of irrigated agricultural land, and is being impacted to differing degrees by landslides induced by water-seepage (see Factor A). The potential for landslide is greatest in the southern portion of the subspecies’ distribution where irrigated lands are closer to, or directly adjacent to, the bluffs (Lindsey 1997, p. 12). In addition, field investigations have determined that Lesquerella (now Physaria) plants can be outcompeted by nonnative, weedy plant species associated with irrigation projects and other disturbance (TNC 1998, p. 5). Therefore, based on the information above, we identify the weathered cliffs at approximately 210–275 m (700–900 ft) above sea level of the White Bluffs of the Ringold Formation exposed by natural erosion as a physical and biological feature essential to the conservation for White Bluffs bladderpod. The habitat includes the adjacent cliff breaks, moderate to gentle slopes (<100 percent slope) to the toe of slope, and flat or gently sloping cliff tops with exposed alkaline paleosols. This habitat is stable with a minimal amount of landslide occurrence. This critical habitat unit was mapped using Universal Transverse Mercator, Zone 11, North American Datum 1983 (UTM NAD 83) coordinates. These coordinates establish the vertices of the unit boundaries. The map in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which the map is based are available to the public at the field office internet site (http:// www.fws.gov/wafwo/HanfordPlants/ FLFCH.html), http:// www.regulations.gov at Docket No. FWS–R1–ES–2013–0012, and at the Service’s Washington Fish and Wildlife Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Physaria douglasii ssp. tuplashensis critical habitat consists of five components (78 FR 76995-77005; 78 FR 24008-24032):

(i) Weathered alkaline paleosols and mixed soils overlying the Ringold Formation. These soils occur within and around the exposed caliche-like cap deposits associated with the White Bluffs of the Ringold Formation, which contain a high percentage of calcium carbonate. These features occur between 210–275 m (700–900 ft) in elevation.

(ii) Sparsely vegetated habitat (less than 10–15 percent total cover), containing low amounts of nonnative or invasive plant species (less than 1 percent cover).

(iii) The presence of insect pollinator species.

(iv) The presence of native shrub steppe habitat within the effective pollinator distance (300 m (approximately 980 ft)).

(v) The presence of stable bluff formations with minimal landslide occurrence.

**Special Management Considerations or Protections**

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Umtanum desert buckwheat. In all of the described units, special management may be required to ensure that the habitat is able to provide for the biological needs of the species. Further studies leading to an enhancement or reintroduction plan may be necessary to increase population size and prepare for recovery postwildfire. More research is needed to determine habitats most suitable for expansion of the current population. In summary, special management considerations or protections should address activities that would be most likely to result in the loss of Umtanum desert buckwheat plants or the disturbance, compaction, or other negative impacts to the species’ habitat. These activities could include, but are not limited to, recreational activities and associated infrastructure, off-road vehicle activity, dispersed recreation, wildfire, and wildfire suppression activities. Special management considerations or protection will conserve the primary constituent elements for the species. Management activities that could ameliorate these threats include, but are not limited to, the fire management plan that has been completed for the Hanford installation (DOE 2011, p. 93) and recently revised to incorporate more detailed management objectives and standards. Though not intended to specifically address Umtanum desert buckwheat, implementation of this plan will contribute to the protection of the primary constituent elements (and physical or biological features) by: (1) Using a map of ‘‘sensitive resources’’ on the site during implementation, including the location of Umtanum desert buckwheat habitat; (2) requiring a biologist to assist the command staff in protecting these environments during wildfire suppression efforts; and (3) restricting public access to the entire Umtanum desert buckwheat site, including the pollinator use area. Public access without security clearance is currently prohibited at the Umtanum desert buckwheat site, reducing the risk of trampling or crushing the plants by ORV use. Special management to protect the designated critical habitat areas and the features essential to the conservation of Umtanum desert buckwheat from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the population and nearby plant community components. These actions may be achieved by detailed fire management planning by the DOE, including rapid response and mutual support agreements between the DOE, the Monument, the U.S. Department of the Army, Bureau of Land Management, and the Washington Department of Fish and Wildlife for wildfire control. These agreements should contain sufficient detail to identify actions by all partners necessary to protect habitat for Umtanum desert buckwheat from fire escaping from other ownerships.

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2013a)

**Lifespan**

Adult: 4 - 5 years (USFWS, 2013a)

**Breeding Season**

Adult: May - July (USFWS, 2013a)

**Reproduction Narrative**

Adult: In a presentation of preliminary life history studies, Dunwiddie et al. (2002, p. 7) reported that most individuals reach reproductive condition in their first or second year, most adult plants flower every year, and the lifespan of this short-lived subspecies is probably 4 to 5 years. Flowers are produced in May, June, and July (USFWS, 2013a).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Cliff, shrubland/chaparral (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 900 - 1,000 ft. elevation (USFWS, 2013a)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Found on a dry, barren, vertical exposure of caliche (a hard, highly alkaline, highly calcalcareous substrate) capping a bluff (Hallock 2002; Washington Natural Heritage 2002). The environmental specificity is very narrow; it is known only from one extensive rock formation (the White Bluffs of the Columbia River), where the plants occur in a highly alkaline caliche-type cemented paleosol that caps several hundred feet of easily eroded alkaline lacustrine sediments

(USFWS, 2004). Terrestrial habitat is characterized as cliff or shrubland/chaparral (NatureServe, 2015). The uppermost part of the Ringold Formation is a heavily calcified and silicified cap layer to a depth of at least 4.6 m (15 ft.). This layer is commonly called ''caliche'' although in this case, it lacks the nitrate constituents found in true caliche. The ''caliche'' layer is a resistant caprock underlying the approximately 274–304 m (900–1,000 ft.) elevation (above sea level) plateau extending north and east from the White Bluffs (Newcomb 1958, p. 330) (USFWS, 2013a).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Number of Populations:**

1 (USFWS, 2020)

**Population Size:**

2,529 to 58,472 (USFWS, 2020)

**Population Narrative:**

The White Bluffs bladderpod population continues to fluctuate greatly among years, with an overall trend of consistently going up and down over time. The monitored portion of the population has ranged from an estimated 2,529 to 58,472 flowering plants since 2013. The size of the entire White Bluffs bladderpod population is uncertain because monitoring occurs only along permanent transects in an area totaling 3.7-km long in the northern part of the subspecies' range. A population viability analysis has not been done and therefore a minimum viable population size has not been estimated. It was suggested that there should be at least 10,500 reproductive individuals in the monitored portion for the population to be considered viable (Caplow 2003, p. 3-3) but as recently as 2015 and 2016 this threshold was not met. Therefore, small population size may continue to be a threat. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Irrigation (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** About one-third of the population is located near or adjacent to irrigated land, where excess groundwater seepage has triggered mass-slope failures (landslides) in the past that obliterate the narrow blufftop soil band in which these plants are found; Lesquerella tuplashensis has not been found in areas disturbed by these landslides (USFWS 2004). Recent incorporation of the area into a national monument/national wildlife refuge may increase capabilities to mitigate this threat somewhat; however, irrigation-dependent farming continues in the area (NatureServe, 2015).

**Stressor:** Pesticide use (NatureServe, 2015)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Pollinators may be affected by use of agricultural pesticides nearby (USFWS, 2004; NatureServe, 2015).

**Stressor:** Invasive species (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Yellow star thistle (Centaurea solstitialis), a highly invasive exotic weed, has been documented in the vicinity (USFWS 2003 & 2004). A seed-predator insect has also been noted in recent years (USFWS, 2004), but it is not known if this is a natural phenomenon or an exotic species introduction (NatureServe, 2015). Cheatgrass is an introduced annual grass that is widely distributed in the western United States, and has been documented in the White Bluffs bladderpod population. Cheatgrass can outcompete native plants for water and nutrients in the early spring, since it is actively growing when native plants are initiating growth. It also completes its reproductive process and becomes senescent before most native plants (Pellant 1996, p. 1–2) (USFWS, 2013b).

**Stressor:** Off-road vehicles (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Off-road vehicles, including mountain bikes, have increased disturbance and erosion, and destroyed individual plants (F. Caplow, pers. comm. cited in USFWS 2003 & 2004) (NatureServe, 2015).

**Stressor:** Fire (USFWS, 2013b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is considered to be a threat to White Bluffs bladderpod, although the decline in population numbers after the 2007 fire indicated the population estimate was still within the known range of variability. Fire events tend to be large and unpredictable in the Hanford Reach (see Table 3) and can potentially affect large numbers of plants and significant areas of pollinator habitat. In addition, wildfire also impacts pollinator communities by directly causing mortality, altering habitat, and reducing native plant species diversity (USFWS, 2013b).

**Stressor:** Predation (USFWS, 2013b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since 1996, some predation by larval insects on developing fruits of White Bluffs bladderpod has been observed. Larvae of a species of Cecidomyiid fly have been observed infesting and destroying flowering buds, and an unidentified insect species has been documented boring small holes into young seed capsules and feeding on developing ovules. However, the overall effect of these insect species on the plants or population is not known (TNC 1998, p. 5). Although insect predation may be a potential threat to White Bluffs bladderpod, more thorough

investigations are necessary to determine its significance to seed production (USFWS, 2013b).

**Stressor:** Utility lines (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since the listing rule, one highly localized and largely temporary potential threat emerged. A 115 kilovolt electrical transmission line (Benton-Othello) crosses the White Bluffs in an area where the subspecies occurs. The line, owned by Avista Utilities (hereafter, Avista), was rebuilt from 2019-2020. Direct (e.g., uprooting plants, crushing plants) and indirect (e.g., increased likelihood of fire or non-native plants) impacts to bladderpod were expected (U.S. Department of Energy 2019, p. 44). Within the subspecies' critical habitat, the estimated disturbance was 0.02 ac permanently and 2.37 ac temporarily. The actual disturbance was less than estimated. Construction techniques were altered to reduce impacts in critical habitat; for example, spoil that would normally be placed in the right-of-way was instead hauled away (U.S. Department of Energy 2019, p. 13). Avista developed a site-specific restoration plan that specifies how damage to the habitat and vegetation will be avoided, minimized, and mitigated (U.S. Department of Energy 2019, p. 16). The Service reviewed a draft of the plan. Revegetation will begin in late 2020 and continue into 2021, with weed control to occur for several years. All disturbed areas not needed for future operation and maintenance of the line will be revegetated with native species (USFWS 2018a, pp. 4-5). Avista will monitor these areas for 5 years to ensure success criteria have been met; if not met, additional restoration and monitoring will occur (U.S. Department of Energy 2019, p. 16). (USFWS, 2020)

***Recovery***

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

Recovery Priority Number: 6C

**Delisting Criteria:**
1) Discover or establish at least one additional population of White Bluffs bladderpod within the Monument or, if possible, on nearby protected lands. These populations will be capable of adapting to changing environmental conditions and be of sufficient size and distribution to withstand stochastic events, such that extinction is highly unlikely (USFWS, 2022).

2) Manage and improve sufficient habitat to support populations wherever they occur (USFWS, 2022).

**Recovery Actions:**
- 1. Monitor population status, trend, and distribution (USFWS, 2022).
- 2. Conduct scientific research to improve understanding of the subspecies' life history, autecology, and limiting factors (USFWS, 2022).
- 3. Protect, conserve, and enhance habitat (reduce or eliminate Factor A threats) (USFWS, 2022).
- 4. Determine the minimum viable population size for White Bluffs bladderpod and the number and distribution of populations needed for long-term viability (USFWS, 2022).

- 5. If needed, increase population size and distribution (reduce or eliminate Factor E threats) (USFWS, 2022).
- 6. Promote outreach and cooperation with partners and stakeholders (USFWS, 2022).

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# SPECIES ACCOUNT: *Physaria filiformis* (Missouri bladderpod)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 01/08/1987; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

**Physical Description**

The Missouri bladderpod is a winter annual, up to 2.5 dm tall, which produces yellow flowers which are especially showy against the plant's silvery stems and foliage. The plants flower, set seed, and die in early spring; the seeds germinate in autumn and overwinter as rosettes. (NatureServe, 2015)

**Taxonomy**

Previously known as Lesquerella filiformis (USFWS, 2008)

**Historical Range**

In addition to its current range, the bladderpod is believed to be extirpated in Jasper and Lawrence counties, Missouri. (USFWS, 1987)

**Current Range**

The Missouri bladderpod currently occurs in four counties in Missouri and five counties in Arkansas and the species is distributed on limestone glades in Southwest Missouri, dolomite glades in northern Arkansas (a report for Missouri on a dolomitic glade has not been confirmed, George Yatskievych, pers. comm. Aug. 11, 2014), and shale glades in the Ouachita Mountains in central Arkansas (Witsell, 2008). (USFWS, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual; self-incompatible (USFWS, 2015)

**Lifespan**

Adult: Less than one year (USFWS, 1988)

**Dependency on Other Individuals or Species**

Adult: Numerous insect species as pollinators (USFWS, 2015)

**Reproduction Narrative**

Adult: The Missouri bladderpod is a winter annual, germinating in the fall and overwintering in the form of basal rosettes. Plants send up flowering stems in late April and flower, fruit and senesce by the end of June. Seeds lie dormant on the limestone glades through the summer and germinate in the fall, starting the life cycle over again. There is considerable variation in these life history details from year to year. (USFWS, 1988) This bladderpod is an obligate outcrosser, being dependent upon several species of pollinators for pollination and fruit set. No less than 38 species of insects in four orders, visited Missouri bladderpod plants (Edens-Meier et al., 2011). (USFWS, 2015)

**Habitat Type**

Adult: Unglaciated prairie areas (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Limestone and dolomitic glades or grazed pastures (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Limestone, dolomitic, or shale substrate (USFWS, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from USFWS, 2015)

**Environmental Specificity**

Adult: Narrow/specialist on specific soils (inferred from USFWS, 2015)

**Site Fidelity**

Adult: High (USFWS, 2015)

**Habitat Narrative**

Adult: The Missouri bladderpod is most commonly found in open limestone glades, barrens, and outcrops within unglaciated prairie areas. It occasionally occurs in dolomitic glades, and is known from one site on a shale substrate. It is often associated with grazed pastures. Cedar invasion of glade sites is common. (NatureServe, 2015; USFWS, 2015)

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 1988)

**Dispersal/Migration Narrative**

Adult: Seeds are mainly dispersed by falling from dried capsules although some dispersal occurs by seeds being washed downhill by rainwater runoff. (USFWS, 1988)

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2015). Unknown. Inferred from information (USFWS, 2020)

**Species Trends:**

Increasing (USFWS, 2015). Unknown. Inferred from information (USFWS, 2020)

**Population Growth Rate:**

Increasing, but annually variable (USFWS, 2015)

**Number of Populations:**

55 total extant. 51 extant in Missouri and 4 in Arkansas (USFWS, 2025).

**Population Size:**

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

**Adaptability:**

Somewhat compatible with residential development and grazing. (NatureServe, 2015)

**Population Narrative:**

When listed, the Missouri bladderpod was not yet known from Arkansas and there were only 11 known populations in Missouri (USFWS, 2003). As of 2015, the species is known from 66 sites in four counties in Missouri and 10 sites in five counties in Arkansas (USFWS, 2003); Rhonda Rimer, pers. comm. Mar.10, 2014, Jan. 14, 2015; Cindy Osborne, pers. comm., Aug. 13, 2014). While the total number of populations now far exceeds the number when listed, an assessment as to whether or not they are self-sustaining is problematic because populations of Physaria filiformis can vary widely from year to year depending on different climatic and edaphic factors and in response to various management practices. For example, Young (2013) monitored populations of Physaria filiformis over a 25-year period on the largest bladderpod site on the Wilson Creek National Battlefield in Missouri and demonstrated that plants fluctuated from a few thousand in 1990, to 261,000+ in 1991, to a few thousand in 1992, to zero in 1993 and 1994, and then rebounded to highs of between 30,000+ and 137,000+ in 1995, and between 42,000+ and 114,000+ in 2011. Similar results have been noted in other areas (USFWS, 2003). While some of the currently known bladderpod sites exceed one-half acre in size, many are much smaller and the distributions of some populations are limited due to the availability of suitable glade habitat. (USFWS, 2015). While populations on managed glades are stable or increasing, data suggest that populations that receive no management are declining. During 2015 and 2016 surveys, Edwards et al. (2019, p. 18) found that P. filiformis was absent or only represented by a single individual in 11 of 25 populations surveyed, and many of these populations showed further decline in 2017. A review of 19 glades surveyed by MDC between 2006 and 2019 demonstrated that seven glades (37%) have stable populations, four have declining populations (21%), and eight are presumed extirpated (42%) (Rhonda Rimer, MDC, Nov. 12, 2019, Dec. 18, 2019, pers. comm.). More than half of Missouri sites have not been surveyed since 2005 and their status is unknown (USFWS, 2020). We received survey data and monitoring reports from MDC and ANHC with updated information regarding the species' status and current threats in the time since we conducted the last 5-year review. Three new sites have been documented since the last review. Results of these efforts indicate that managed populations in Missouri and Arkansas are stable and that unmanaged populations may be declining rapidly. No new threats have been documented since the last 5-year review. As described above, the recovery criteria outlined in the recovery plan has not been met. Eleven of 30 self-sustaining populations occur on public land; however, four of these occur in the Ouachita Mountains and may be reclassified as a different species in the future. Fourteen populations either occur on protected land or privately owned land but are being managed by a conservation agency. The exclusion of populations in the Ouachita Mountains would reduce the number of protected populations range-wide from 14 to 10. (USFWS, 2020) . For purposes of this analysis, the terms "sites," "occurrences," and "populations" have been used interchangeably in Arkansas and Missouri natural heritage databases or in published literature. Seven new populations of Missouri bladderpod have been discovered in Missouri and one in Arkansas since the last 5-year review (Rimer, pers. comm. 5

Sep. 2024). Currently, there are 75 sites of Missouri bladderpod in Missouri and 8 in Arkansas (Soteropoulos 2023). One of the sites in Missouri at the Nathan Boone State Historic Site was a result of seed dispersal from an adjacent site in 2020-2021 (Crabtree, pers. comm. 28 Sep. 2024). Of the 75 naturally occurring, known sites in Missouri, 24 (32%) of these sites are extirpated or likely extirpated (Rimer, pers. comm. 5 Sep. 2024). Since the last 5-year review, approximately 21 of the known sites in Missouri were monitored (~ 28%). Leis (2023) monitored sites on the Wilson Creek National Battlefield and used a gridbased survey approach (Young et al. 2008) to monitor 10 known Missouri bladderpod sites and established a midpoint of population estimates. Leis noted that bladderpod numbers increased following dormant season burns. Soteropoulos (2023) monitored all known sites of Missouri bladderpod in Arkansas and noted that some populations were the largest ever recorded in the state, and some of the increases were due to clearing of competing vegetation or prescribed fires (Soteropoulos 2023; Benton, pers. comm. 20 Sep. 2024). Based on Edwards et al. (2021), Edwards et al. (2023), and Kallison et al. (submitted for publication August 2024), populations of Physaria sp. on shale glades in the Ouachita Mountains represent a new species. A manuscript on the new species (Physaria ouachitensis E.R. Hallison & C.E. Edwards) was submitted to Systematic Botany and is currently under review (Edwards, pers. comm. Sep. 19, 2024). Given probable approval, the new species in the Ouachita Mountains would remove four populations from the overall range of the species (see further discussion in section 4). Prior to 2023 it would have been three sites, but Benton discovered one new site in Garland County in 2023 on a shale substrate (Benton, pers. comm. 20 Sep. 2024). Approval of the new species would also remove one natural community from the range of P. filiformis. Of the 51 extant sites in Missouri, 23 (45%) are in public ownership (Rimer, pers. comm. 9 Sep. 2024). Assuming the bladderpod that occurs on shale glades in the Ouachita Mountains is accepted as a new species, only two sites with Missouri bladderpod in Arkansas would be in public ownership [Blue Springs Recreation Area in Northwest Arkansas- Beaver Lake North and Beaver Lake South (Soteropoulos 2023)]. Therefore, 25 of the currently known 55 (~45%) sites for P. filiformis rangewide are in public ownership. While some of the currently known Missouri bladderpod sites exceed one-half acre in size, many are much smaller, and the distributions of some populations are limited due to the availability of suitable glade habitat. There are populations that would increase if various management actions were undertaken [e.g., removal of woody vegetation, especially red cedar; control of invasive brome (Bromus spp.) grasses] but the original recovery goal of one-half acre of size was based on limited data on only 11 sites when the recovery plan was completed in 1988. Recovery criteria could be updated and revised to address the current knowledge of the species' life history requirements, distribution, and new information on management actions that can benefit the species and address known threats. Given information obtained since the recovery plan was approved in 1988 regarding variations in areal coverage of some bladderpod sites, the habitat size criterion may not benefit recovery. (USFWS, 2025)

***Threats and Stressors***

**Stressor:** Human disturbance and collection (USFWS, 1987)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The low number of individual plants make the species vulnerable to collecting and other human disturbance. Two of the populations are within the Wilson's Creek National Battlefield, where a system of interpretive trails extends through the sites. These populations

receive some disturbance from the more than 124,000 annual visitors to the Battlefield site, but Morgan (1983) concluded that disturbance may help maintain the Lesquerella filiformis populations. In addition, wildflower collectors may reduce populations in more accessible sites. As Steyermark (1963) pointed out, this plant with handsome yellow flowers makes a desirable addition to rock gardens and may be vulnerable to overcollecting. (USFWS, 1987)

**Stressor:** Lack of management research (USFWS, 1987)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Research is needed to determine proper management techniques for maintenance of the species, especially at disturbed sites. (USFWS, 1987) Consistent glade management maintains suitable habitat for P. filiformis and is considered vital to the survival and recovery of populations in Arkansas and Missouri. Removal of Eastern red cedar (Juniperus virginiana), prescribed fire, and control of exotic species allow for the persistence and expansion of populations. Many privately owned glades in Missouri are not being managed to promote the persistence of this plant species, and surveys indicate generally low numbers of P. filiformis. With a few exceptions, glades on private lands are over-shaded by encroaching Eastern red cedar, intensively grazed, densely covered by grasses and forbs, and not managed with fire (Christine Edwards, MOBOT, Nov. 12, 2019, pers. comm.). Although restoration efforts increase abundance of P. filiformis, implementation of those efforts on privately-owned glades is challenging (Rhonda Rimer, MDC, November 12, 2019, pers. comm.). Similar to Missouri, glade habitat in Arkansas has become degraded at several locations due to lack of management. (USFWS, 2020)

**Stressor:** Right-of-way maintenance (USFWS, 1987)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Three populations of Lesquerella filiformis occur in Dade County within Missouri highway rights-of-way. Two of these populations extend onto private land. Because of yearly right-of-way treatments, there is a threat of destruction to these populations. Cooperation with the State Department of Highways and Transportation is necessary in order to provide these sites additional protection from accidental mowing or chemical treatment. (USFWS, 1987)

**Stressor:** Seed destruction (USFWS, 1987)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Seed predation by insects and fungal infection of developing capsules have been reported by Morgan (1983). It is not known whether the ensuing loss of reproductive capacity constitutes a significant threat to the species. (USFWS, 1987)

**Stressor:** Competition from native and exotic plants (USFWS, 2003; 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Shortly after listing, the Service (1988) documented the presence of exotic plant species, such as Bromus tectorum (a cheat grass), in bladderpod habitat as a significant threat,

and this was further supported by observations by Hickey (1988, 2000) and Thomas (1996, 1998). (USFWS, 2003) Witsell (2008) and Eulinger and Skinner (2007) noted that encroachment by Eastern red cedar onto glades causes habitat degradation and this threat will need to be continually monitored. (USFWS, 2015)

**Stressor:** Development (USFWS, 2003)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hickey (1988, 2000) and Thomas (1996) identified development, especially land-use changes resulting from urban expansion, as a major threat to the species. (USFWS, 2003)

**Stressor:** Climate change (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change may lead to increased frequency and duration of droughts (Rind et al., 1990; Seager et al., 2007; Rahel and Olden, 2008). Climate warming may increase the virulence of nonnative parasites and increased drought conditions may favor the establishment and spread of nonnative species (Rahel and Olden 2008). Extended droughts and an increase in soil and air temperatures could negatively impact seed set, germination, and overall fitness of Physaria filiformis. (USFWS, 2015)

***Recovery***

**Reclassification Criteria:**
The bladderpod has already been reclassified from endangered to threatened based on discovery of new populations and reduced threats to large existing populations. (USFWS, 2003)

Recovery Priority Number: 8

**Delisting Criteria:**
The Missouri bladderpod may be considered for delisting when there are thirty scattered, self-sustaining populations of Lesquerella filiformis that are maintained and protected. Fifteen of the thirty populations must be in secure ownership, occupy a minimum of one-half acre of habitat each, and show self-sustaining populations for at least seven years. (USFWS, 1988)

**Recovery Actions:**
- Existing populations need to be protected and managed. (USFWS, 1988)
- Suitable habitat needs to be surveyed for new populations. (USFWS, 1988)
- Populations need continuing monitoring; autecological and management research is needed on the species. (USFWS, 1988)
- Management programs need to be developed and then initiated on protected sites. (USFWS, 1988)
- New populations need to be established on public land. (USFWS, 1988)
- Programs need to be developed to enhance public awareness and support for conservation of the species. (USFWS, 1988)

- The establishment of measurable recovery criteria that address threats to the species should be developed and implemented before possible delisting is recommended. (USFWS, 2015)
- A revision of the 1998 Missouri Bladderpod Recovery Plan is needed to develop measurable delisting criteria that reflect remaining threats to the species and to incorporate new information that has been obtained in the last 26 years. Development of such a plan should be done in cooperation with the appropriate experts and stakeholders in Missouri and Arkansas. (USFWS, 2015)
- Missouri bladderpod numbers and the results of ongoing conservation efforts need to be regularly monitored to assess recovery and ongoing management efforts. It may be appropriate to identify priority populations in Missouri and Arkansas for monitoring. Monitoring efforts should include populations that occur on the three different substrate types. (USFWS, 2015)
- Studies need to be initiated on the potential impacts of climate change on the Missouri bladderpod and its habitat. The species could be impacted from droughts and accompanying problems associated with climate change; further research is warranted. (USFWS, 2015)
- Physaria filiformis would benefit from additional genetic studies that evaluate genetic diversity across the range of the species, especially given the now known large geographic gaps between populations in southwest Missouri and scattered populations in Arkansas and the occurrence on three different soil substrates. (USFWS, 2015)
- Outreach efforts need to be made to private landowners in Missouri and Arkansas regarding best management practices that will maintain, and where necessary restore bladderpod habitat. (USFWS, 2015)
- Ongoing survey efforts should continue to search for new populations, especially in Arkansas. (USFWS, 2015)
- Viable sites should be protected and properly managed in all the outlying clusters within the species' range. (USFWS, 2015)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The Service provides the following recommendations: 1. Revise the recovery plan to include measurable delisting criteria that appropriately reflect remaining threats to the species and new information that has been obtained in the last 31 years. The plan should define "self-sustaining" and identify how often populations should be monitored within a 7-year period to meet that definition. Development of such a plan should be done in cooperation with the appropriate experts and conservation partners in Missouri and Arkansas. 2. Monitor populations and use results to assess efficacy to further recovery efforts. Recovery criteria cannot be met unless ≥30 populations are monitored. 3. Assess the status of populations in Missouri that have not been surveyed since 2010. Examine what proportion of unmanaged, extant populations in Missouri are threatened by overgrazing, encroaching Eastern red cedar and invasive grass and forb species, as well as changing land use practices that may result in extirpation of populations. 4. Implement a simple, standardized survey to count or estimate the number of plants present in Missouri and Arkansas populations. 5. Conduct outreach efforts with private landowners in Missouri and Arkansas regarding best management practices to maintain, and where necessary, restore habitat for Missouri bladderpod. 6. Collect data to evaluate whether or not application of herbicide spraying to populations along rights of way and roadways in Arkansas negatively affect P. filiformis. 7. Implement management practices such as prescribed burning and removing Eastern red cedar and non-native plant species within glades. Develop and implement additional management plans in Missouri and Arkansas to maintain habitat on private and public lands to further recovery efforts for this plant species. 8. Protect and manage more of the populations that occur on privately owned land through an appropriate combination of financial incentives, acquisition, easements, and logistical support. 9. Continue to protect and manage at least one population within each distinct genetic group and two populations from the genetically distinct group that occur in Sharp and Izard Counties, Arkansas. 10. Conduct a morphological study to determine if populations located in the Ouachita Mountain in Arkansas are a different species. (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS: The Service provides the following recommendations: 1. Edwards et al. (2021) recommended the collection of seed from genetic clusters they identified. A threatened and endangered species seed bank proposal has been submitted to MDC's Science Branch by the Missouri Botanical Garden that will help ensure that the range-wide genetic diversity is represented in ex-situ conservation (Malissa Briggler, State Botanist, MDC, pers. comm. 10 Oct. 2024). 2. Based on genetics results outlined by Edwards et al. (2021), ongoing monitoring should be undertaken at a minimum of the six genetic clusters identified in Arkansas and Missouri. Due to the number of extant sites in Missouri and Arkansas, and a general lack of personnel, there will likely be a need to prioritize what sites are monitored. Simple presence/absence monitoring may be insufficient to assess the status of Missouri bladderpod in Arkansas and Missouri, especially sites with high genetic diversity as determined by Edwards et al. (2021). Monitoring as outlined by Young et al. (2008) and Leis (2023), or a program supported and coordinated among Federal and State agencies in Missouri and Arkansas, should be implemented. The need for an increased level of monitoring at priority sites notwithstanding, only 28% of known sites in Missouri were surveyed between 2020 and 2024 (Rimer, pers. comm. 5 Sep. 2024). At least presence/absence monitoring should be conducted on Missouri sites that have not been visited in several years. 3. In Arkansas, Soteropoulos (2023) determined that there was "considerable habitat in Arkansas suitable for the species that remains under-surveyed and under-inventoried," and Benton (pers. comm. 20 Sep. 2024) reported that surveys in un-inventoried habitat are planned for the spring of 2025. Consequently, we recommended enhanced survey effort in suitable habitat in Arkansas. 4. Because Missouri bladderpod is a conservation-reliant species as described above, private land-owner incentive programs could be investigated that ensure long-term conservation of Missouri bladderpod while providing financial benefits to landowners. Possible landowner incentive programs include: a Recovery Credit System and a Conservation Award System (Wilkins et al. 2009; Kreuter 2017); conservation management agreements (Scott et al. 2005; Bocetti et al. 2012); credit marketing (Wolfe et al. 2017); and conservation banking for multiple species (Evans et al. 2016). One of the more innovative approaches has been the development of a Covenant Program for Environmentally Endangered Lands in Florida that provided as much as a 90% reduction in property taxes for private landowners who signed up in the program (Giannini and Heinen 2014). 5. Conduct an analysis of the projected impact of future residential and commercial development on existing bladderpod habitat. In Missouri, populations in Christian and Greene counties are projected to significantly increase between 2000 and 2030 (Missouri Economic and Resource Report 2024). Because some of our largest populations have historically occurred in these two counties (MDC Natural Heritage Database 2024), residential and commercial development on private property could eliminate bladderpod habitat. 6. Conduct an analysis on changes in suitability of glade habitat in Missouri and Arkansas. Young et al. (2009) provided startling photos depicting changes in bladderpod habitat on Bloody Hill Glade of Wilson's Creek National Battlefield between 1936 and 2003. Similar analyses of potential bladderpod habitat may reveal that areas now completely enclosed due to canopy closure from red cedar encroachment were historically more open as noted by Nelson (2005). The identification of such areas could be identified as priority areas for restoration efforts using clearing and prescribed fire. 7. Conduct outreach efforts with private landowners in

Missouri and Arkansas regarding best management practices to maintain, and where necessary, restore habitat for Missouri bladderpod. Provide technical assistance and cooperatively work with private landowners in restoration efforts. 8. Evaluate whether herbicide spraying along rights of way and roadways in Missouri and Arkansas negatively affects Missouri bladderpod. 9. Continue to protect and manage at least one population within each distinct genetic group and two populations from the genetically distinct group that occur in Sharp and Izard Counties, Arkansas as recommended by Edwards et al. (2021). 10. Based on genetic analyses of Edwards et al. (2021), Missouri bladderpod on COE land in northwest Arkansas is experiencing a genetic bottleneck. Consideration should be given to the possibility of increasing the genetic diversity of northwest Arkansas plants by supplementing existing populations with seeds from the most geographically proximal site in Arkansas or Missouri. Such augmentations will require close coordination among Missouri and Arkansas natural heritage botanists, U.S. Army Corps of Engineers personnel, USFWS staff, and geneticists from the Missouri Botanical Garden. 11. Conduct an analysis on which environmental variables affect yearly demographic trends in Missouri bladderpod and incorporate that information into a future SSA. (USFWS, 2025)

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# SPECIES ACCOUNT: *Pinguicula ionantha* (Godfrey's butterwort)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 8/11/1993; Southeast Region (R4)

**Physical Description**

Pinguicula ionantha has a rosette of fleshy, oblong, bright green leaves that are rounded at their tips, with only the edges rolled upward. The rosette is about 15 cm (6 in) across. The upper surfaces of the leaves are covered with short glandular hairs that capture insects. The flowers are on leafless stalks (scapes) about 10-15 cm (4-6 in) tail. When a flower is fully open, its corolla is about 2 cm (almost 1 in) across. The five corolla lobes are pale violet to white. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. The corolla has a spur 4-5 mm (0.2 in) long that is yellow to olive (Godfrey and Stripling 1961, Godfrey and Wooten 1981). (USFWS, 1994)

**Taxonomy**

Pinguicula ionantha Godfrey (Godfrey’s butterwort or violet-flowered butterwort) is a member of the bladderwort family (Lentibulariaceae), a small family of carnivorous plants closely related to the snapdragon family (Scrophulariaceae) (USFWS, 1994). Pinguicula L., the second most diverse genus of the carnivorous Lentibulariaceae, is monophyletic and composed of about 85 to 100 species native to Europe, North America, Asia, and South and Central Americas (Cieslax et al. 2005, Degtjareva et al. 2006). Six species can be found in Florida, of which P. ionantha Godfrey is endemic (Gluch 2005). All Florida species belong to the section or subgenus Isoloba (Fleischmann 2021, Cieslax et al. 2005, Gluch 2005). We are not aware of any changes to the taxonomy of this entity, and it is still considered valid by the Service and the scientific community (USFWS, 2023).

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to the central panhandle region of Florida with reported occurrences in Bay, Calhoun, Franklin, Gulf, Liberty, and Wakulla counties (USFWS, 2018).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: Pinguicula L., the second most diverse genus of the carnivorous Lentibulariace is monophyletic and composed of about 85 to 100 species native to Europe, North America, Asia, South and Central America, and southern Mexico (Cieslax et al. 2005, Degtjareva et al. 2006). Members of this genus use sticky, glandular leaves to trap and digest insects (USFWS, 2009). It is unclear what benefit the plant derives from this carnivory.

**Breeding Season**

Adult: The flowers rise from late February to April according to temperatures (USFWS, 2009).

**Reproduction Narrative**

Adult: Pinguicola ionantha has a rosette of fleshy, bright green-yellow leaves of up to 15 cm across that can be characterized by upward rolled leaf edged. The plants stay in rosette form all year. The flowers rise from late February to April according to temperatures. The flowers, borne on stalks of about 10 to15 cm in height, are about two centimeters across and possess five pale violet to white petals all of same shape corolla. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. A yellow to olive spur 4 to 5 mm long is present on the corolla and the palate is yellow with a purple base and covered with yellow hairs (Godfrey and Stripling 1961, Godfrey and Wooten 1981) (USFWS, 2009). SEXUAL; ABIOTIC; Wind; (NatureServe, 2015)

**Habitat Type**

Adult: Bos/long leaf pine savannas (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred form NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred form NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits open, acidic soils of seepage bogs on gentle slopes, deep quagmire bogs, ditches, and depressions in grassy pine flatwoods and grassy savannas, often occurring in shallow standing water. "Pinguicula ionantha occurs in herb bog habitats embedded in longleaf pine savannas. Specifically, it is found between a lower elevation habitat dominated by pond cypress (Taxodium ascendens) overstory and a slightly higher elevation pine flatwoods dominated by an overstory of longleaf pine (Pinus palustris) (USFWS 2009) (NatureServe, 2015). High ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the species specific habitat needs.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: No information found.

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2018)

**Species Trends:**

Unknown (USFWS, 2018)

**Population Growth Rate:**

It is estimated that between 85 and 98% of herb bog/savanna habitats have been lost (Folkerts 1982 cited by Kesler et al. 2008). Decline of >70% (NatureServe, 2015)

**Number of Populations:**

~66. (approximately 54 occurrences on public lands and an additional 12 on private lands) (USFWS, 2023).

**Population Size:**

2500 - 100,000 individuals (NatureServe, 2015)

**Additional Population-level Information:**

Previously, 83 historical sites were documented between 1956 and 2009 (FNAI 2008). Based on information provided by FNAI (2017) and FWCC (2018) and recent surveys, the number of sites has increased to 92; technically representing 66 EOs. About 10,558 plants were present at 21of the 23 EOs revisited in 2015 (Molano-Flores et al. 2014). A total of 52 sites were visited in 2006, 2008, and 2009 surveys: 33 sites were revisited by Kesler and Trusty (2008) during April 2006, and 19 sites were visited by Negrón-Ortiz during 2008 and 2009 surveys. Plants were present at 24 (46%) of these sites. Searches did not locate plants at 22 (42%) of the previously recorded sites. Additionally, high water or a dense woody midstory prevented access to six previously recorded sites in Gulf and Franklin counties (Kesler and Trusty 2008, Negrón-Ortiz, 2008 surveys). This species appears to be increasing in number of populations on public lands. However, overall trends in both abundance of individuals within each population and the total number of populations through the species range remain unknown. (USFWS, 2018)

**Population Narrative:**

Current survey information indicates an increase in the number of populations. Survey information shows 22 (33%) of the 66 EOs appear to be extirpated due to development and/or habitat modification. However, since surveys were conducted irregularly and based on either presence/absence and/or qualitative visual estimate (Jenkins et al. 2007); with most sites visited only once; and the actual counts of plants rarely provided, a comprehensive population survey is needed in order to better assess the current status of this species. Studies have demonstrated variation among the number of plants necessary for a population to survive risks of extinction (Given 1994, Matthies et al. 2004, Menges 1990). Matthies et al. (2004) study of 379 populations of eight threatened plant species in northern Germany demonstrated that very small populations face a considerable risk of extinction, while the risk for populations with more than 1000 individuals was very small. Because most of the P. ionantha populations have less than 1000 individuals, any impact to existing populations (specifically sites outside the ANF) could cause extirpation of these populations. Furthermore, the relatively low level of genetic diversity associated with this species is a concern as it may impair fitness and evolutionary adaptability in a changing environment (Zaya et. al 2016). (USFWS, 2018). Godfrey’s butterwort is a carnivorous plant presently located in six Florida panhandle counties. The species’ populations primarily found on Apalachicola National Forest and Tate’s Hell State Forest. There are approximately 54 occurrences on public lands and an additional 12 on private lands. Most of the P. ionantha populations have less than 1000 individuals, therefore any impact to existing populations (specifically sites outside the Apalachicola National Forest) could cause loss of these populations (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Logging and Pulpwood Production (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Privately owned forests managed (clearcutting, mechanical site preparation, and bedding) for commercial timber production, is a primary threat to P. ionantha habitat. An active paper mill located in Panama City (Bay County) receives timber from thousands of acres of pine plantation. The commercial timber industry in North Florida became well established in the 1850's (FNAI 2005). It started in Franklin County in the 1870's and continued to be a prominent industry until the mid-1990's (Howell and Hartsell 1995). The Timberland Company had close to a million acres in timber production in the eastern region of the Panhandle and they plan to continue to commercially harvest and replant off-site pine species. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. In 2013, the Timberland Company sold more than 380,000 acres of its land to AgReserves, Inc.. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Within Gulf County, AgReserves, Inc. has repurposed timberlands into pasture lands for cattle (A. North, FDEP, 2/6/2018, pers. comm.). (USFWS, 2018)

**Stressor:** Coastal real estate and road development (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Urban development continues to threaten Godfrey's butterwort. The Timberland Company is one of the largest private landowners in Florida, and one of the largest real estate operating companies in the Southeast. The Company develops both residential and commercial properties along roadways and near or within business districts in the region. More than a third of Florida's land is projected to be developed by 2070 along with a grow of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Many P. ionantha locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable habitat; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Evidence suggests past road improvements have resulted in localized extirpation of Godfrey's butterwort in ANF (Kesler and Trusty 2008). Therefore, because they contribute to habitat loss, road widening and new roads continue to pose a threat to the species. (USFWS, 2018)

**Stressor:** Fire suppression (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Suppression of fire during the growing season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly

develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent, low intensity prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., < 3 yr interval, are needed to maintain optimal habitat for P. ionantha populations (Kesler et al. 2008). At present, the Apalachicola National Forest utilizes a 3- to 5-yr interval burn rotation (2-4 yr burn rotation at the burn units with P. ionantha, J. Drake, USFS, 02/21/2018, pers. comm.); Box-R WMA and SJBSBP utilize 2- to 3-yr interval; and Lathrop Bayou applies prescribed fire on a 2- to 7-yr interval. Thus, fire suppression continues to threaten to P. ionantha habitat and population numbers. Lack of fire, and subsequent growth of shrubs (particularly encroachment of Cyrilla racemiflora L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008, Kesler et al. 2008). Declining fire frequency reduces P. ionantha abundance in areas where it was previously observed in large quantities (FNAI 2008). Emergence of this species is prolific within one year of the fire event (Kesler and Trusty 2008). (USFWS, 2018)

**Stressor:** Over collection (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** This factor is a threat, but the magnitude has been reduced. Butterworts are widely cultivated, grown and sold by plant enthusiasts and nurseries. Pinguicula ionantha was overcollected in the 1970s (58 FR 37440). Many thousands of plants propagated by tissue culture were sold without permits, but the plant is no longer commercially available in large quantities (D'Amato, California carnivores). In order to implement conservation measures and regulations, the Service granted a permit (TE061005-1) to the International Carnivorous Plant Society (ICPS) in 2003, which allows the society to sell seeds of endangered and threatened carnivorous plants only within the USA. Some restrictions apply to this permit (see http://www.carnivorousplants.org/conservation/policies); in addition, an annual report is required stipulating their selling activities. Collecting guidelines for live plants and seeds were developed by the ICPS: 1) they do not recommend collecting live plants unless it is for scientific purposes such as herbaria, the species has never been introduced to cultivation, or because a variant (a taxon exhibiting slight differences in form); 2) they will not accept field collected seed of listed plants, only seeds from cultivated plants will be accepted if they are donated in accordance with all relevant laws. The Nurseries Stock Restrictions manual summarizes the entry status of regulated plant material capable of or intended for propagation (USDA 2010). (USFWS, 2018)

**Stressor:** Hurricanes (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Saltwater inundation from storm surges caused by hurricanes represents a threat. Kesler and Trusty (2008) monitored one population in Franklin County, which was flooded during Hurricane Francis in 2004. In 2005, they observed that the plant number declined from about 100 to two individuals. (USFWS, 2018)

**Stressor:** Sea Level Rise (USFWS, 2018)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter above current sea level. Being endemic to Florida, Godfrey's butterwort is threatened by climate change. Using the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer (https://coast.noaa.gov/slr/), the projections indicated potential impacts to six known P. ionantha EOs (Bay Co.: 1 EO; Franklin Co.: 5 EOs) by intrusion of saltwater beginning at one foot SLR. (USFWS, 2018)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Section 7(b)(4) and 7(b)(2) of the Endangered Species Act (Act) generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed threatened and endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulations or in the course of any violation of a State criminal trespass law. Seeds of both threatened and endangered species found on Federal land are regulated under the Act. However, the seeds of threatened species are not regulated if they come from cultivated plants (7 CFR 319.37.2, USDA 2008). Since P. ionantha is a threatened species, growers can obtain and sell seeds from other growers. Several populations of P. ionantha occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. The Act does not provide for protection of plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of State-listed plants from their property. Pinguicula ionantha is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). Bay County Comprehensive plan, under chapter 6, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (http://baycountyfl.gov/276/Planning-Zoning). Calhoun, Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting protected species, then the Service can recommend consultation to the FDOT under section 7 of the Act. The FDOT routinely consults with the Service on all major road construction activities. (USFWS, 2018)

***Recovery***

**Reclassification Criteria:**
Not relevant. (USFWS, 1994)

Recovery Priority Number: 8C

**Delisting Criteria:**
1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

**Recovery Actions:**
- Manage ROW Continue fostering conservation practices for utility and highway Right-of-Ways with the Forest Service, FDOT, and USFWS; a ROW Best Management Practices plan should be developed and implemented. (USFWS, 2018)
- Develop a stand-alone plan for managing listed plants at the Apalachicola National Forest and THSF, and integrate it to their Management Plan. (USFWS, 2018)
- Conduct a long-term study using 15 populations distributed throughout the species' historical range for 10 years to determine whether the observed declines in abundance reflect acceptable stochasticity or if they are indicative of dangerously declining populations. This study could use the sites from Kesler and Trusty (2008) study, and will address the delisting criterion. (USFWS, 2018)
- Since habitat loss and degradation are leading causes of endangerment for P. ionantha, designating habitat that is critical for survival and recovery is recommended. (USFWS, 2018)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the species' status. (USFWS, 2018)
- Conduct surveys/inventories on potentially new sites. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought, and identify sites for reintroductions such as areas that will not be affected by SLR and future development (USFWS, 2018)
- Establish (or continue) frequent growing-season fire regimes (i.e., 2-3 yr interval) on selected areas such as Apalachicola National Forest, SJBSBP, THSF, and Tyndall AFB to maintain optimal conditions of P. ionantha populations. Re-visit sites shortly after a burn event, and mark and count individual plants. Populations tend to be more evident after a fire event. (USFWS, 2018)
- Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. (USFWS, 2018)
- Investigate if there is a soil seed bank persistence of P. ionantha seeds throughout the species geographic range. (USFWS, 2018)
- Conduct population biology studies at Apalachicola National Forest. Compare the demographic performance of P. ionantha in pinelands and road habitats. Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in or near roadside populations of SR 65 and pinelands. (USFWS, 2018)
- The recovery plan should be updated to define objective measurable criteria and better address the five listing factors.(USFWS, 2018)
- 1. Manage ROW

- 2. Since habitat loss and degradation are leading causes of endangerment for P. ionantha, designating habitat that is critical for survival and recovery is recommended (USFWS, 2009).
- 3. Evaluate the current species status (USFWS, 2009).
- 4. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites (USFWS, 2009).
- 5. Establish frequent growing-season fire regimes (i.e. 2-3 yr interval) on selected areas such as Tate's Hell State Forest, St. Joseph State Buffer Preserve, and ANF to maintain optimal conditions of P. ionantha populations. Re-visit sites shortly after burn event and mark individual plants. Populations tend to be more evident after a fire event (USFWS, 2009).
- 6. Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. Studies on the viability of dry-stored seeds, the timing of the germination, and whether a persistent seed bank is present should be addressed (USFWS, 2009).
- 7. Conduct population studies at ANF (USFWS, 2009).
- 8. Conduct systematic studies to examine the current taxonomic classification (USFWS, 2009).
- 9. Conduct pollination studies (USFWS, 2009).
- 10. The recovery plan should be updated to define objective measurable criteria and better address the five listing factors (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES 1. Address the delisting criterion, 'adequately protect and manage 15 populations distributed throughout the species' historical range for 10 years'. This study could use the sites from Kesler and Trusty (2008) established plots. a. Continue the long-term monitoring ANF, Tyndall, and LB sites, and set up plots in SJSBP and THSF. b. As sea levels rise, seawater intrusion increases in duration, frequency, and spatial extent. To assess the effect of salinity on P. ionantha, sites where intrusion of salt water occurs should be considered for long-term monitoring. 2. Conduct surveys/inventories on potentially new sites. a. Calhoun and Wakulla counties. Historically, P. ionantha was documented in Wakulla and Calhoun. Therefore, surveys are strongly recommended in these counties within the habitat types or vegetation communities associated with the species. b. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. 3. Manage ROW Continue fostering conservation practices for utility and highway ROWs with the Forest Service, FDOT, and USFWS; a ROW Best Management Practices plan should be developed and implemented. 4. Develop a stand-alone plan for managing listed plants at the ANF and THSF, and integrate it to their Management Plan. 5. Since habitat loss and degradation are leading causes of endangerment for P. ionantha, designating habitat that is critical for survival and recovery is recommended. 6. Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the species' status. 7. Establish (or continue) frequent growing-season fire regimes (i.e., <4 yr interval) on selected areas such as ANF, SJBSBP, THSF, and Tyndall to maintain optimal conditions of P. ionantha populations. Re-visit sites shortly after a burn event, and mark and count individual plants. Populations tend to be more evident after a fire event. 8. Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. In February 2016, 238 plants were removed from the F-22 Munitions Storage Complex on Tyndall AFB prior to new bunker construction and relocated to a wet prairie at Tyndall AFB. Post-transplanting monitoring is ongoing since 2017. 9. Investigate if there is a soil seed bank persistence of P. ionantha seeds throughout the species geographic range. The following studies were inconclusive; therefore, better observations are needed to clarify the type of seed bank present in this species. A few points from these studies: • The lack of a persistent seed bank was suggested by Kesler et al. (2008), as they observed a 430-day delay in the population growth response of P. ionantha to dormant season fires. • Molano-Flores et al. (2014) found the emergence of two Pinguicula seedlings from soil collections, but identification to species was not possible because seedlings did not reach the flowering stage during the study. • Molano-Flores et al. (2021) subsequent seed germination and seed bank studies on multiple populations of P. ionantha, P. lutea, and P. planifolia suggest: o transplanting seedlings is not recommended unless moisture and humidity are retained, and root disturbance is minimized. o sprouted seeds of P. ionantha with emerging cotyledon, previously soaked in gibberellic acid solution and rinsed with distilled water, were transplanted to a soilless mixture but did not survive o 6 months post-collection seeds kept in cold storage for about 5 months have high potential for germination o viability potential of seeds in the seed burial trail was at least 2 months (that was the duration of their study) 10. Conduct population biology studies at ANF Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in or near roadside populations of SR 65 and pinelands (USFWS, 2023).

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# SPECIES ACCOUNT: *Pityopsis ruthii* (Ruth's golden aster)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015) 7/18/1985

**Physical Description**

A perennial herb, 1-3 dm tall. The stems are leafy with grass-like leaves. Bright yellow flower heads bloom in late summer and fall (NatureServe, 2015).

**Taxonomy**

Past taxonomic treatments of Ruth’s golden aster, and golden asters in general, have involved frequent shifting of species among genera. Small (1897) described the species as Chrysopsis ruthii but subsequently transferred it to the genus Pityopsis (Small 1933), a genus characterized as those golden asters with graminiform (grass-like) leaves. This concept was rejected by Fernald (1942) who described the recognition of Pityopsis as “hardly worthwhile” and retained the species in Chrysopsis. Later, Shinners (1951) included Chrysopsis in his concept of the genus Heterotheca. His treatment generally was accepted by Harms (1969), who published the combination Heterotheca ruthii, and by Bowers (1972b) and Cronquist (1980). Dress (1953), in his study of the eastern Chrysopsis, continued to follow Small’s 1933 nomenclature (except in the case of the Pityopsis graminifolia complex). Semple (1977), Semple et al. (1980), and Semple and Bowers (1985) reaffirmed Heterotheca, Chryopsis, and Pityopsis as distinct genera. Semple’s work is widely accepted, and Ruth’s golden aster will be referred to here as Pityopsis ruthii (Small) Small. It is instructive to note that no student of the genus has questioned the validity of the species, only the proper generic designation (USFWS, 1990).

**Historical Range**

See current range/distribution.

**Current Range**

Known only to occur along short reaches of the Ocoee and Hiwassee River, Polk County, Tennessee (USFWS, 2018).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Reproduction in natural populations is attributed to stem regeneration or tillering of the subaerial root-rhizome crown (Wofford and Smith 1980). This agrees with White (1977), who stated that the chief method of reproduction is by existing rhizomes. White observed no seedlings in the field and concluded that P. ruthii has difficulty becoming established on the phyllite boulders. His comparison of plants from the Hiwassee River population with those grown for his greenhouse studies showed an average of 50 achenes and 58 achenes per flowering head, respectively. Typically, 18 percent of those achenes from the wild population were filled (i.e., viable) compared to 19 percent from the greenhouse populations. Although White (1977) presented no figures on percentage germination of the filled achenes he sowed during his greenhouse study, he indicated that 62 percent of the P. ruthii seedlings resulting from the 960 filled achenes sown survived their first 3 weeks. It is suggested that a combination of wind and nonselective foraging by insects could account for the low percentage of filled achenes (Wofford and Smith 1980). No studies of pollinators or of pollination in P. ruthii have been performed. However, in the field, Bowers (1972a) noted several kinds of bees visiting the flowers of various members of the section Pityopsis (including P. ruthii), and in the greenhouse he observed occasional visits by flies to the flowers of the same species. He determined that members of the section Pityopsis are obligate outcrossers and that self-fertilization and apomixis seldom, if ever, occur. He also concluded that wind is of little importance in pollination. White (1977), while collecting soil samples in the field, observed numerous ant colonies sharing the same crevices with P. ruthii. He suggested there may be a relationship between the presence of the ants and the establishment of P. ruthii but made no further investigation of this potential relationship. Production of low numbers of viable seeds could easily contribute to difficulties in the establishment of new plants. Ineffective dispersal methods also could be a contributing factor. While Wofford and Smith (1980) stated that “age class determinations indicate only mature individuals are present,” there was evidence that regeneration from seeds is occurring. In an ongoing study of P. ruthii, Collins and Gunn (1986) observed one subpopulation on the Hiwassee River comprising 1,149 individual plants. Relative to other subpopulations measured in 1986 and 1987, a greater preponderance of those plants were small and single-stemmed and were not located near enough other larger plants to have come from rhizomes. The same subpopulation was measured the next year (Collins and Gunn 1987), and 307 fewer individuals were found, perhaps the victims of stress from severe drought. Apparently many of the absent individuals were the small, single-stemmed plants recorded the prior year. It is possible that many of those plants were young seedlings, not yet vigorous enough to withstand the extreme conditions at the time. Furthermore, a great many more individuals not producing flowering heads were seen than were found by Wofford and Smith (1980). The extent and significance of predation upon P. ruthii are not known. White (1977) observed predation by the larvae of three moth species on plants in the greenhouse. In the field, Collins and Gunn (1986) also have observed insect larvae apparently feeding on the achenes in the maturing heads of some plants (USFWS, 1990).

**Habitat Type**

Adult: The species is restricted to outcrops of phyllite (rarely greywacke) within 5.7 km (3.5 mi) and 4.6 km (2.9 mi) reaches of the Hiwassee and Ocoee Rivers, respectively (USFWS, 2018).

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits soil-filled cracks in phyllite boulders along river banks and in rivers, within 5.7 km (3.5 mi) and 4.6 km (2.9 mi) reaches of the Hiwassee and Ocoee Rivers, respectively (USFWS, 2018). Shade intolerant but adapted to annual high water flows; requires periodic flooding and scouring to remove competing vegetation (NatureServe, 2015). High ecological integrity of the community and site fidelity along with low tolerance ranges are noted based on the species specific habitat requirements and the relatively low number of populations (NatureServe, 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (inferred from USFWS, 1990)

**Dispersal**

Adult: Low (inferred from USFWS, 1990)

**Dispersal/Migration Narrative**

Adult: No study of fruit dispersal has been made, but the pappus is disposed to dissemination by wind. According to Wofford and Smith (1980), dispersal also is achieved by water. They regarded effective dispersal as rare, based on the paucity of observations of seedlings in nature, but provided no supportive data (USFWS, 1990). Low mobility and dispersal are inferred based on rare effective dispersal of the species.

***Population Information and Trends***

**Population Trends:**

Stable to decreasing (USFWS, 2018)

**Species Trends:**

Decreasing (USFWS, 2018)

**Number of Populations:**

2 (USFWS, 2023)

**Population Size:**

~100,000 total individuals (USFWS, 2023)

**Population Narrative:**

As of 2017, the population from the Ocoee River was relatively stable from 2011 through 2017 ranging from a low of 1,140 during 2011 to a high of 1,299 individuals in 2015. As of 2017, there were 1,232 individuals, an overall increase of 82 individuals (7.2 percent) compared to the baseline census in 2011. Data collection on the Hiwassee River has occurred at a total of 57 sites, but only 27 sites have been counted annually. These 27 sites account for more than 90 percent of all plants counted in each year from 2011 through 2017, thus are representative of trends for the population on this river. Data from the Hiwassee demonstrate that a period of increase occurred from 2011 through 2014, followed by decreases through 2017. Using data from the 27 sites counted annually, as of 2017 there has been a decrease of 1,676 individuals (17.6 percent) compared to the 2011 baseline and a decrease of 4,125 individuals (34.5 percent) since 2014, when the population peaked (USFWS, 2018). A study from 2013 showed moderate genetic diversity in three populations sampled and a study from 2018 determined that gene flow levels among populations within each river were sufficient to reduce risk of divergence due to genetic drift. The species is restricted to two populations located along short reaches of the Hiwassee and Ocoee rivers, in Polk County, Tennessee. Available data indicate that the Ocoee River population has increased by approximately 20 percent since 2011, to a total of 1,388 individuals in 2022. While it is the larger of the two populations, the species abundance in the Hiwassee River population has decreased by approximately 10 percent since 2011, to a total of 8,968 individuals in 2022 (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Encroachment of competing vegetation (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** There are concerns about the loss of habitat in the Hiwassee drainage to encroachment of competing herbaceous and woody vegetation. A Biological Assessment prepared by TVA (2002) discussed the threat posed to the Hiwassee population by vegetation encroachment onto the phyllite boulders due to altered flows in the river below Apalachia Dam since its construction in 1943. They identified this threat as the cause for the observed decline of P. ruthii since monitoring began in 1986. Several lines of evidence support this conclusion, including the general declining trend in the Hiwassee population since monitoring began, the finding of Thomson and Schwarz (2006) that all Hiwassee populations suffered mean negative growth rates except for one plot from which vegetation had been removed in the past, and Cruzan's (2000) observation that vegetative cover in the Hiwassee floodplain has increased approximately 50 percent since the late 1940s (USFWS, 2012). Continued ecroachment and habitat reduction contributes to decreases in P. ruthii in some sites. As abundance decreases, pollinator attraction could decrease, potentially creating a negative feedback loop reducing reproductive output and contributing to further declines (USFWS, 2018).

**Stressor:** Altered flow regimes (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Altered flow regimes (due to the Apalchia dam) and encroachment of competing vegetation into suitable habitat in the Hiwassee drainage remain the greatest active threats for P. ruthii. Because the process of vegetation encroachment has occurred over a period of several decades, riparian communities have become established on the phyllite boulders to the extent that periodic high flows alone would not be enough to remove this threat and restore P. ruthii habitat (USFWS, 2012). Maintenance work in 2015-2016 on the Apalachia powerhouse and switchyard caused elevated flows for 132 days in the Hiwassee River where P. ruthii occurs and a decline in this population was observed. Drought conditions also occurred during part of 2016, which could also account for the decline in the observed Ocoee River population (USFWS, 2018).

**Stressor:** Recreation (USFWS, 2012)
**Exposure:**
**Response:**

**Consequence:** Loss of individual plants
**Narrative:** The development of a whitewater recreation facility on the Ocoee River and hosting of whitewater events during the 1996 Olympics elevated concerns about recreation-related impacts to P. ruthii, both from whitewater paddlers and spectators. The USFS-CNF recommended corrective measures to reduce recreation-related impacts at two sites (Doublesuck and Tablesaw) where they were found to be greatest (Herrig and Wyrick 1996). The threat of trampling by spectators at the Tablesaw site was reduced by the extension of a guardrail on the nearby highway, eliminating parking access in close vicinity to this population. However, no billboard or kiosk has been constructed at the access point for paddlers upstream of Doublesuck, to inform paddlers of the presence of P. ruthii and biologically sensitive areas near particular whitewater features (USFWS, 2012). No adverse effects from whitewater recreationists or observers have been reported since 2015 (USFWS, 2018).

**Stressor:** Road construction (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The Tennessee Department of Transportation is currently analyzing transportation alternatives for Corridor K, which passes through the Ocoee River Gorge and based on a preliminary map of targeted spot improvements, some of the road construction would occur along US HWY 64 where it parallels sites on the Ocoee River that P. ruthii occupies. A Section 7 consultation has not been completed and therefore the potential for adverse effects to P. ruthii that could result from implementing the Targeted Approach have not been analyzed (USFWS, 2018).

**Stressor:** Disease or predation (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Five potential invertebrate herbivores have been observed on P. ruthii in situ and ex situ plants and can damage flower buds and developing seeds (USFWS, 2018).

**Stressor:** Hybridization (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The potential for hybridization to occur between Heterotheca ruthii (=P. ruthii) and H. graminifolia (=P. graminifolia var. latifolia) was first documented by Bowers (1972), in a cross that produced only two seeds, one of which germinated and died within a week. Moore et al. (2016) report that P.A. Wadl (unpublished data) produced viable offspring from controlled crosses between these species. Recent evidence (Boggess 2013, Hatmaker et al. 2018, P. Wadl 2018, pers. comm.) indicates that wild hybrids may be formed where these two species co-occur. Hybridization could present a threat to reproductive output and genetic variation (USFWS, 2018).

**Stressor:** Climate change (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Using NatureServe's Climate Change Vulnerability Index (CCVI) to assess P. ruthii's predicted exposure to climate change, the species was ranged as highly to extremely vulnerable indicating that abundance and/or range extent or are either likely to decrease significantly (highly vulnerable), or extremely likely to substantially decrease or disappear (extremely vulnerable), by 2050 (Young et al., 2015)(USFWS, 2018). Drought experienced in 2016 and 2017 contributed to declines of this species and very likely reduced seedling establishment given that seedling emergence has been observed to occur beginning in November (USFWS, 2018).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5C

**Delisting Criteria:**
The Ocoee River population, under the criteria described in or to be established by implementation of Task 7, is deemed recovered and the rate of natural succession on the phyllite boulders on the Hiwassee River is determined to not be detrimental to the survival of P. ruthii (USFWS, 1990).

The Hiwassee River population, under the criteria described in or to be established by implementation of Task 6, is deemed recovered and Tasks 7.2, 7.3, 7.4, and 7.6 are accomplished for the Ocoee River population.

Pityopsis ruthii shall be considered recovered when the full set of recovery goals (Tasks 6 and 7) for each population is fulfilled (USFWS, 1990).

**Recovery Actions:**
- 1. Maintain formal agreements among the appropriate concerned agencies on the preservation of Pityopsis ruthii.
- 2. Maintain permanent plots.
- 3. Determine what is necessary for effective and successful achene dispersal. seed germination, and seedling establishment. 3.1 Study achene dispersal. 3.2 Determine life history. seed germination, and seedling establishment requirements. 3.3 Determine the role of interspecific and intraspecific competition.
- 4. Determine what constitutes suitable habitat.
- 5. Search for Pityopsis ruthii on other rivers.
- 6. Determine and implement for the Hiwassee River population the management necessary for long-term reproduction, maintenance, and vigor. 6.1 Determine and compare Past and present stream flow regimes. 6.2 Determine the nature and role of natural succession on the phyllite boulders. 6.3 Determine whether or not the population is self-sustaining. 6.4 Establish P. ruthii on unoccupied suitable habitat. 6.5 Establish a cultivated population of plants descended from the Hiwassee River population and provide for long-term seed storage. 6.6 Determine feasibility and/or necessity of water releases and hand-clearing of phyllite boulders (USFWS, 1990).
- 7. Determine and implement for the Ocoee River population the management necessary for long-term reproduction, maintenance, and vigor. 7.1 Study the relationship of the river to P. ruthii. 7.2 Determine impacts of river recreational users and implement required

management actions. 7.3 Ensure that highway construction will not damage or destroy plants or suitable habitat. 7.4 Determine whether the population is self-sustaining. 7.5 Establish P. ruthii on unoccupied suitable habitat. 7.6 Establish a cultivated population of plants descended from the Ocoee River population and provide for long-term seed storage (USFWS, 1990).

- 8. Variability in population trends among sites in the Hiwassee River suggests that demographic monitoring of selected sites would be useful in understanding which life history stages are most affected by threats to the species and its habitat. Demographic monitoring will be necessary for evaluating effectiveness of any future efforts to reintroduce the species into suitable unoccupied habitat (USFWS, 2018).
- 9. Future restoration projects should explore effects of planting season and importance of mycorrhizal associations on establishment, survival, growth, and reproduction of introduced plants. Additionally, if restoration into suitable habitat is to be successful, multiple outplantings over time likely will be necessary at any given site (USFWS, 2018).
- 10. For each mapped location on the Hiwassee River, record data on apparent vulnerability to vegetation encroachment, including observations on substrate composition (e.g., bedrock, boulder, cobble, gravel, degree of sediment deposition), landform and aspect. Use these data to map risk of local extinction and assess whether and where management is needed to control vegetation encroachment (USFWS, 2018).
- 11. Incorporate observations on presence and relative abundance of Pityopsis graminifolia var. latifolia at monitoring sites, to document locations where potential threat of hybridization is greatest (USFWS, 2018).
- 12. Coordinate with TDOT to avoid potential adverse effects to P. ruthii from road construction activities on US HWY 64 (USFWS, 2018).
- The primary actions needed to move P. ruthii towards a status at which downlisting or delisting could be considered, include: 1. Determining effective methods for controlling vegetation encroachment and restoring degraded habitat in the Hiwassee drainage (USFWS, 2012).
- 2. Implementing a vegetation control and habitat restoration program to restore suitable habitat conditions across the occupied range in the Hiwassee drainage. For long-term prevention of repeated vegetation encroachment, altering flows to provide sufficient frequency and duration of scouring of phyllite boulders will likely be necessary (USFWS, 2012).
- 3. Analyzing and comparing contemporary flow regimes (i.e., since 1943) on the Hiwassee River to pre-impoundment flow regimes (USFWS, 2012).
- 4. Conducting future surveys of P. ruthii populations in the Hiwassee drainage in order to assess (1) the degree to which suitable habitat for the species declines due to vegetation encroachment and (2) whether the species' linear distribution along the Hiwassee River changes over time (USFWS, 2012).
- 5. Developing effective reintroduction methods for establishing P. ruthii in suitable habitat, in order to fulfill recovery tasks 6.4 and 7.5 (USFWS, 2012).
- 6. Ensuring that recommendations for controlling whitewater recreation-related threats to the Ocoee population are implemented (USFWS, 2012).
- 7. Continuing long-term monitoring effort that has been implemented by TVA, USFS-CNF, and TDEC (USFWS, 2012).
- 8. Continuing annual meetings of the RCWG to coordinate recovery efforts (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities In the absence of river flows sufficient to regulate vegetation encroachment in many sites where Pityopsis ruthii occurs along the Hiwassee River, it could be necessary to develop effective approaches for mechanical or chemical control to prevent the species' displacement from some sites where this threat of encroaching vegetation is most aggressive. It would likely be infeasible to conduct such intensive management at the scale of the entire occupied reach, owing to the remoteness of the area and other environmental considerations (e.g., presence of endangered mussel species and designated critical habitat in this reach of the Hiwassee River). A management plan identifying the areas under the greatest threat and that guides incremental habitat restoration over a period of several years, however, may need to be developed in order to advance recovery of the species at a biologically meaningful scale. Additionally, flow prescriptions could be developed to regulate vegetation encroachment and enhance P. ruthii habitat, as discussed below. Monitoring and Research Activities The 2012 and 2018 5-year status reviews for Pityopsis ruthii discussed at length how a better understanding of artificially regulated river flows in the Hiwassee River and their influence on P. ruthii population growth could inform the development and implementation of more ecologically compatible flow prescriptions. The presumed importance of river flows that inundate occupied P. ruthii habitats at a frequency sufficient to regulate encroachment of competing herbaceous and woody vegetation are discussed in the species recovery plan, which calls for an analysis of contemporary and historical flow regimes to understand how flow alterations have contributed to changes in riparian vegetation conditions and availability of suitable sites for P. ruthii. Hydrological reference conditions for the Hiwassee River, however, are unavailable prior to the closing of Apalachia Dam. An alternative approach for understanding how flows interact with vegetation and suitable sites for P. ruthii would be to adapt a methodology used for assessing effects of river flows on another species in the family Asteraceae, beautiful Barbara's buttons (Marshallia pulchra) (Tracey and Simmerman 2021). These methods could be adapted to investigate relationships between discharge, depth and duration of inundation, and response of P. ruthii and the associated vegetation community to compare these dynamics for the Hiwassee River to the Ocoee River, where conditions have supported population increase for more than a decade of monitoring. With a better understanding of the relationship between river flows, habitat inundation, and P. ruthii population responses in both river systems, it might be possible to prescribe a flow regime that would support population growth in the Hiwassee River population. A collaborative effort leveraging the authorities and resources of multiple partners, such as the U.S. Fish and Wildlife Service, Tennessee Valley Authority (TVA), American Whitewater Association, US Forest Service, and Tennessee State Parks, could potentially take on such an investigation to advance the status of the species (USFWS, 2023).

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# SPECIES ACCOUNT: *Plagiobothrys hirtus* (rough popcornflower)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** Plhi

**Listing Status:** Endangered; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Rough popcornflower plants are between 7 centimeters (cm) (2.75 inches [in]) to 60 cm (23.6 in) tall, with narrow, simple hairy-margined bright-green leaves along hairy stems. The non-fragrant flowers consist of five fused petals, are trumpet-shaped, mostly white with yellow centers, and positioned in a hairy calyx. The flowers are helicoid in development and occur on paired coiled inflorescences. Each flower produces four tan to black-colored, one-seeded nutlets, which loosely adhere to the receptacle, until they drop. These nutlets will germinate readily (Amsberry and Meinke 2002, p. 24). However, due to fruit abortion or lack of pollination, flowers with fewer than four nutlets are often observed. As in most members of the Boraginaceae family, anthers are included and epipetalous (having stamens attached to the inner corolla surfaces. Rough popcornflower can be either an annual or a short-lived perennial. Rough popcornflower exhibits two distinct growth forms in the northern and southern portions of its range in Douglas County. In the northern part of its range near Yoncalla, the plants are more robust, slightly taller, and predominantly perennial (Figure 1). Here rough popcornflower has the ability to produce adventitious roots that easily establish in the moist soil of their wetland habitats. In the southern part of the range, 25.8 kilometers [km] (16 miles [mi]) south of the Yoncalla population, from the general area of Sutherlin to Wilbur, the population include annual plants, often in clusters, with a few sporadic perennial plants. The rough popcornflower and fragrant popcornflower (P. figuratus) are found in similar wetland habitat in northern Douglas County. Both are members of the subgenus Allocarya (Peck 1961, p. 66), and are quite similar in appearance. Rough popcornflower differs from fragrant popcornflower in that the entire plant is larger and has less fragrant flowers, hairier stems and fruits, more robust stems, and blooms several weeks later. The larger rough popcornflower plants grow with more arched stems as well. A stout, hairy (on the upper part of the stems) annual, 3-6 dm tall, with long, narrow leaves and white flowers. Blooms primarily from mid to late June. (NatureServe, 2015)

**Taxonomy**

Allocarya hirta Greene was the original scientific name applied to the species in 1888. Since then, the species has undergone a number of taxonomic re-arrangements, including Allocarya scouleri var. hirta, Allocarya calycosa, and Plagiobothrys scouleri var. hirtus. Since the 1961 edition of Plants of Oregon, it has remained Plagiobothrys hirtus (Peck 1961, p. 661), and this classification is recognized as valid by the U.S. Department of Agriculture Plants Database (U.S. Department of Agriculture 2018, website) and the Integrated Taxonomic Information System (Integrated Taxonomic Information System 2019, website).

**Historical Range**

Rough popcornflower is found only in northern Douglas County, Oregon, occurring at low elevations (100 and 230 meters (m) [328 to 755 feet [ft]) within the Umpqua River basin, distributed in the Elk Creek, Umpqua River, and Lower North Umpqua River watersheds.

**Current Range**

Rough popcornflower has been documented at 23 populations historically; 18 are extant and 5 are extirpated. Five of the known populations occur on private land and lack monitoring access. Despite this, the species is estimated to have greater than 883,154 mature, reproductive individuals across its range. Of the 18 extant populations, 1 is very large (700,000 plants), 10 are relatively large (5,000-70,000 plants), 4 are medium (1,000-4,999 plants), and 3 are small (less than 1,000 plants). While smaller populations, in general, are more vulnerable to extirpation from stochastic events and genetic drift than larger populations (Szczecińska et al. 2016, p. 17; Ma et al. 2013, p. 805), the majority of rough popcornflower populations support more than 5,000 individuals and we believe are less susceptible to stochastic events and genetic issues.

**Critical Habitat Designated**

No;

**Legal Description**

NA

***Life History***

**Food/Nutrient Resources**

**Competition**

Adult: Competes with both invasive and native plants

**Food/Nutrient Narrative**

Adult: water availabilty is dependent on annual weather patterns and heavy clay soils

**Reproductive Strategy**

Adult: r strategy, species relies on outcrossing but can self if necessary

**Reproduction Narrative**

Adult: Popcornflower can be a perennial, growing to 70 cm tall (27.5 inches), with dozens of flowering stems and hundreds of flowers, or can be a diminutive annual with only a few flowers (Amsberry and Meinke 2001). At Popcorn Swale Preserve, rough popcornflower generally reaches peak growth and flowering by mid-June. By July 1, many plants have dropped seed and are senescing. By July 15, rough popcornflower generally appears gray-brown and crispy although a rare flower or two may be found low to the ground in moister, shaded areas. Although most plants are dormant by mid-July, perhaps around 1% of individuals may still be green and actively growing and flowering. Rough popcornflower, like most borages, can potentially produce four nutlets per flower. In most sites, copious numbers of mature seeds were observed from mid-June through early September, but plants in a few wetter habitats delayed seed maturation until the beginning of August. The number of seeds produced by individual plants is largely controlled by the number of flowers produced, and correspondingly, large plants produce more flowers (USFWS, 2016). Pollination biology of rough popcornflower is not well documented but we are not currently considering lack of pollination or seed production a stressor, but are more concerned with connectivity and habitat quality since pollination is dependent of habitat corridors of an adequate variety of native and non-native plants (habitat quality). We know that the typical high seed set indicates that pollination is highly successful since the flowers are visited by a diverse group of generalist pollinators, and that pollination is not currently a limiting factor for this species. Connectivity and habitat quality is essential to ensure that genetic exchange is taking place within and among populations by these pollinators (U.S. Fish and Wildlife Service 2003, p. 54). (USFWS, 2021b)

**Habitat Type**

Adult: River valley wetlands (USFWS, 2016)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from USFWS, 2016)

**Environmental Specificity**

Adult: Very narrow to narrow. (Natureserve, 2015)

**Habitat Narrative**

Adult: Rough popcornflower is a plant closely associated with seasonally wet, relatively level, open habitats in Douglas County formed from poor draining clay-loam soils, concentrated in the Sutherlin Creek basin in Oregon. These wet habitats are unique to the Sutherlin area and correspond to a particular type of soil series known as Conser silty clay-loam. The majority of rough popcornflower populations largely correspond to Conser soils, which is a poorly draining silty clay-loam series soil. To a lesser extent, the species occurs on clay or loam soils including Bashaw clay, Brand silty clay loam, Curtin clay, Dixonville silty clay loam, Nonpareil loam, Oakland clay-loam, Packard silty loam, Philomath-Dixonville complex, Sibold clay, and Waldo silty clay loam soil types. Rough popcornflower habitat corresponds to emergent wetlands within seasonally wet meadows or prairie, seasonally-ponding mudflats, and Oregon ash (Fraxinus latifolia) swale openings dominated by native wetland-associated herbs and graminoids in valley lowlands where the ground is moist well into the summer season. The species appears to be adapted to early seral succession habitat so it does not often occur under dense shade. Native perennial plant species commonly associated with rough popcornflower habitat include Oregon ash, dense sedge (Carex densa), green-sheathed sedge (C. feta), one-sided sedge (C. unilateralis), spreading rush (Juncus patens), pointed rush (J. oxymeris), common rush (J. effusus), tufted hairgrass (Deschampsia cespitosa), great white camas (Camassia leichtlinii), rush-leaved coyote thistle (Eryngium petiolatum), Willamette gumweed (Grindelia integrifolia), and western mannagrass (Glyceria occidentalis). Native annuals commonly associated with rough popcornflower include American sloughgrass (Beckmannia syzigachne), skullcap speedwell (Veronica scutellata), Cascade calicoflower (Downingia yina), and Douglas meadowfoam (Limnanthes douglasii). Common invasive plant associates in rough popcornflower habitat include trees (e.g. European pear [Pyrus communis]); shrubs (e.g. Armenian blackberry [Rubus armeniacus] and English hawthorn [Crataegus monogyna]); herbaceous plants (e,g. meadow knapweed [Centaurea moncktonii], teasel [Dipsacus fullonum], Canada thistle [Cirsium arvense], pennyroyal [Mentha pulegium], and curly dock [Rumex crispus]); and graminoids (e.g. reed canarygrass [Phalaris arundinacea] and tall fescue [Schedonorus arundinaceous]). Pennyroyal and tall fescue are nearly always present in or around rough popcornflower habitat. Rough popcornflower appears to be a species that requires early seral habitat and is not associated with habitat under dense tree or shrub canopies. Grazing helps to control invasive and native plant competitors and provides a measure of disturbance that maintains the preferable more-early seral and open habitat conditions for rough popcornflower. Flooding, fire, and native ungulate grazing, also likely played a large role in the development and maintenance of habitat for the plant (U.S. Fish and Wildlife Service 2000, p. 3867). When such natural disturbance events are lacking, active management is necessary to control competing vegetation and maintain requisite conditions for this plant to compete with naturally occurring and non-native plant species. An increase in abundance of Oregon ash or spreading rush can result in a loss of rough popcornflower habitat without mowing, grazing, or fire to restore habitat suitability (USFWS 2021).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Has increased from 8 populations at the time of listing to 18 populations. (USFWS 2021).

**Resiliency:**

We assessed habitat conditions for rough popcornflower in terms of habitat area, population size, habitat quality, connectivity, management, protection, reproduction, abundance of insect pollinators, and rainfall. Of the 18 total rough popcornflower populations, 11 had a higher probability of persistence, 3 had a moderate probability of persistence, and 4 had a low expected persistence over the next 30 years. (USFWS 2021)

**Representation:**

An abundance of insect pollinators and habitat connectivity leads to genetic diversity by the process of cross-pollination between patches within a population. There is a need to maintain the genetic variation between populations as their potential genetic and life history attributes may buffer the species to adapt to environmental changes over time. At this time, we do not know the degree of genetic variation among rough popcornflower populations and whether connectivity and active genetic exchange is occurring across populations and within patches or within populations. Most rough popcornflower populations are not isolated from one another by over 2.0 km (1.24 miles) and it is assumed that gene flow occurs among the majority of the population. (USFWS 2021)

**Redundancy:**

Rough popcornflower requires multiple resilient populations distributed throughout its range to provide for redundancy. The more populations, and the wider the distribution of those populations, the more redundancy the species will exhibit. Redundancy reduces the risk that a large portion of the species' range will be negatively affected by a catastrophic natural or anthropogenic event at a given point in time. (USFWS 2021)

**Population Growth Rate:**

From 7,000 individuals at the time of listing has increased to a total population estimate of over 883,154 individuals. (USFWS 2021).

**Number of Populations:**

18 are extant and 5 are extirpated. (USFWS 2021)

**Population Size:**

883,154 individuals (USFWS 2021)

**Minimum Viable Population Size:**

Although a minimum viable population hasn't been determined, based on studies by Lande (1995) and Lynch et al. (1995) we have recommended the recovery level population size for rough popcornflower as 5,000 plants per population. This figure is based on the authors' suggestion that in most cases, 5,000 individuals in a population, is necessary to maintain above normal levels of potentially adaptive genetic variability under a balance between mutation and random genetic drift. Without a Population Viability Analysis (PVA) to indicate what an optimal abundance level should be, using our best professional judgement, we consider a population with over 5,000 mature plants to be in high condition, over 1,000 plants to be in medium condition, and under 200 plants to be in low condition.

**Adaptability:**

We have no documentation of rough popcornflower's adaptability. Maintaining representation in the form of genetic or ecological diversity will provide rough popcornflower the capacity to adapt to future environmental changes.

**Population Narrative:**

Rough popcornflower has been documented at 23 populations historically; 18 are extant and 5 are extirpated. All known populations (naturally occurring and reintroductions) occur in Douglas County, OR. Five of the known populations occur on private land and lack monitoring access. Despite this, the species is estimated to have greater than 883,154 mature, reproductive individuals across its range. Of the 18 extant populations, 1 is very large (700,000 plants), 10 are relatively large (5,000-70,000 plants), 4 are medium (1,000-4,999 plants), and 3 are small (less than 1,000 plants). The majority of rough popcornflower populations support more than 5,000 individuals and we believe are less susceptible to stochastic events and genetic issues. Through extensive surveys and augmentation and introduction efforts, the 7,000 individuals within 8 populations known at the time of listing has increased to 18 populations, with a total population estimate of over 883,154 individuals. The bulk of this estimate includes a single extensive rough popcornflower population south of Sutherlin, which has not been adequately censused but may have as many as 700,000 individuals.

***Threats and Stressors***

**Stressor:** Competition (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Stressors to rough popcornflower habitat include encroachment by Oregon ash and European pear, Armenian blackberry and English hawthorn, pennyroyal, teasel, Canada thistle, curly dock, spreading rush and reed canarygrass), which compete for moisture, light, and space. Pennyroyal is nearly always present in rough popcornflower habitat and is an ever-present competitor. (USFWS, 2021, p. 17).

**Stressor:** Development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat

**Narrative:** Development was described as a serious stressor to rough popcornflower. In addition, habitat can become degraded by both channelization (e.g. ditching) and filling of wetland habitat.(USFWS,2021, p. 17)

**Stressor:** Agriculture (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The species appears to be adapted to early seral succession habitat and cannot compete with later successional vegetation such as Oregon ash, rushes, and tall fescue for light, moisture, and space. Stressors to rough popcornflower habitat include encroachment by Oregon ash and European pear, Armenian blackberry and English hawthorn, pennyroyal, teasel, Canada thistle, curly dock, spreading rush and reed canarygrass), which compete for moisture, light, and space. Pennyroyal is nearly always present in rough popcornflower habitat and is an ever-present competitor.

**Stressor:** Fire suppression (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Fire suppression resulting in encroaching native oaks and ash trees that shade popcornflower and reduced gene flow due to habitat fragmentation are considered to be other threat factors (USFWS 2010).

**Stressor:** Urban and Rural Development (USFWS, 2021b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Urban and Rural Development. The final listing decision (U.S. Fish and Wildlife Service 2010, p. 3869) described how rough popcornflower populations had become fragmented due to draining and filling of wetlands from properties being developed, primarily in the city of Sutherlin area. For example, between 1995 and 2002, four rough popcornflower populations were either heavily impacted or lost due to urban development, mostly prior to the species' listing. Currently, we consider urban development in the general vicinity of Sutherlin (within and just beyond the Urban Growth Boundary) as a threat to four populations (Hawthorne, Southside Swale, Sutherlin East, and Stearns Lane). However, 11 of the 18 populations (151,195 of 883,154 total plants) throughout the species' range are under Federal, State, municipal, or land trust protections providing for the long-term persistence of these populations. At other privately owned populations on rural pasturelands (Horsepasture 2, Nonpareil), long-term persistence has been documented for over 30 years. Additionally, developers, State and Federal wetland regulators, and city and county governments are doing an increasingly better job of recognizing rough popcornflower habitat and avoiding and minimizing (or mitigating) development impacts. Because the majority of the population is protected and the species is benefitting from increased awareness, the threat posed by development has been significantly diminished. Nine rough popcornflower populations occur on Federal, State and Municipal owned lands, where management of the species is directed by species-specific management plans and regulations (Table 2). Rough popcornflower is distributed across properties with a mix of ownership (Table 2) and land use practices. These land use practices on privately owned land may or may not be

consistent with rough popcornflower conservation. For example, while some landowners mow rough popcornflower during its growing period, seed with non-native pasture grass, and use selective herbicides to promote hay or agricultural crops (i.e., practices that can be detrimental to the species), other landowners are interested in conserving the species, mow, and graze when competition with invasive non-native species is problematic for the species. As discussed above in the Habitat section, some forms of land use practice can be beneficial to the species. The fact that lands are held in private ownership in and of itself does not constitute a threat to the species. In fact, three of the largest rough popcornflower populations occur on private lands where the property is not specifically managed to benefit the species (Table 2). Of the 18 extant rough popcornflower populations, 4 with greater than 5,000 individuals occur partially or wholly on private lands which are grazed beneficially for the species. At the time of listing, only five populations of rough popcornflower were protected from detrimental land-use activities. Since listing, significant progress has been made in protecting and managing sites supporting rough popcornflower. Because 12 of the 18 of the populations are now considered protected or on adequately managed land, the threat from development activities is no longer as severe. (USFWS, 2021b)

**Stressor:** SMALL POPULATION SIZE (USFWS, 2021b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The final listing rule (U.S. Fish and Wildlife Service 2000, pp. 3869-3870) described the distribution of the rough popcornflower as 17 small patches (approximating 7,000 plants) which were threatened by natural (i.e., flood) and / or anthropogenic (e.g., herbicide treatment) events. At the time, the species' small population size was considered a threat because a single natural or man-made event could have the potential to extirpate a small rough popcornflower patch. Although small populations occur that are still vulnerable to extirpation, there are now multiple, large populations of rough popcornflower occurring in patches larger than those at the time of listing, providing added resilience to the species. In addition, at the time of listing there were concerns that a small, isolated population might not be able to sustain adequate genetic variation, or that reproduction may be impaired (see Fertilization, below). There was also a concern that a lack of connectivity between isolated patches and populations would limit pollinator-mediated gene flow. Since then, these concerns have since been alleviated to a significant extent. At the time of listing, the limited number of individuals and populations was considered a threat. Today, eight of the 18 populations are dispersed over a much larger area (over 500 m2 [5382 ft2 ]) than in the past and are likely large enough to withstand a single random natural or anthropogenic event. However, the Hawthorne, Stearns Lane, and Ford's Pond populations are located in small discrete areas and are vulnerable. Even so, these small populations are broadly distributed and the likelihood of large-scale event affecting them collectively is unlikely. Overall, while this species' relatively small population is still of some concern, it is much less vulnerable than when it was listed. (USFWS, 2021b)

**Stressor:** HERBIVORY (USFWS, 2021b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory by Columbian white-tailed deer (Odocoileus virginianus leucuruswas), black-tailed deer (Odocoileus hemionus columbianus), assorted rodents, and livestock, particularly

sheep, has occasionally been documented and could be a threat to rough popcornflower (U.S. Fish and Wildlife Service 2000, p. 3871). Densities of white-tailed and black-tailed deer are high in much of the Sutherlin Creek area and generally overlap with the distribution of rough popcornflower. Deer herbivory was evident following introduction of rough popcornflower to a wetland mitigation site (U.S. Fish and Wildlife Service 2020, p. 2) and some evidence of sheep herbivory has been documented (U.S. Fish and Wildlife Service 2000, p. 3871). Despite the densities of deer, herbivory does not appear to be causing widespread damage to most rough popcornflower populations. (USFWS, 2021b)

**Stressor:** INVASIVE PLANT ENCROACHMENT (USFWS, 2021b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Non-native invasive plants are a primary threat to the establishment of rough popcornflower due to their encroachment of habitat and elimination of bare-ground, which popcornflower seeds require to germinate. Invasive pennyroyal is present at many rough popcornflower sites and controlling this species requires constant effort and is a management priority at the NBHMA, TNC Popcorn Swale Preserve, and Red Rock Park populations. Similarly, teasel and Canada thistle control requires constant effort at the NBHMA, Yoncalla South and the TNC Popcorn Swale Preserve populations. Reed canary grass covered over 70 percent of the Red Rock Park rough popcornflower site for several years and required three years of repeated manual weeding efforts and herbicide treatments to reduce this invasive plant to manageable levels. As discussed above, rough popcornflower is conservation reliant in that some form of active management is necessary to maintain habitat in an early-successional condition. For example, prescribed fire, mowing, manual weeding, and herbicide treatment may be required to help maintain many of the rough popcornflower populations into the future (U.S. Fish and Wildlife Service 2010, p. 27). This is exemplified by the active management practices and population response at multiple locations (see Appendices 2 and 3). Invasive plants appears to be less of a concern on private lands because livestock grazing controls invasive plant growth (citation). Strategic grazing by livestock, in terms of seasonal grazing periods and intensity, when closely monitored, can benefit rough popcornflower populations by reducing plant competition and creating open ground that facilitates seed germination and enables population expansion (U.S. Fish and Wildlife Service 2020, p. 2). Competition with invasive plants is an ongoing threat to rough popcornflower. However, investments in weed control and lessons learned in how to combat invasive species has resulted in flourishing populations. A continued commitment will be needed to maintain these populations (see Appendices 3 and 4). While invasive plants remain a threat to rough popcornflower, this threat can be successfully managed. (USFWS, 2021b)

**Stressor:** FIRE (USFWS, 2021b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing, fire was considered a necessary natural event key to the formation and maintenance of rough popcornflower habitat (U.S. Fish and Wildlife Service 2000, p. 3867). In late September 2003, an accidental fire occurred at the Soggy Bottoms meadow within the BLM's NBHMA and burned across the introduced rough popcornflower population. The intensity of the fire was moderate but did not sterilize the soil's organic layers. Following the burn, staff noted that individual rough popcornflower plants were much larger, robust, and the

population increased from 1,193 plants in July 2003 to 1,869 plants in July 2004. However, by 2009 the population had been reduced to 15 individuals. The BLM and the Service attributed the rapid population decline to factors other than the burn, including changes in water flow and increased erosion due to stream channelization at the site that affected the hydrology of the site. While the effects of fire in rough popcornflower habitat restoration are still unknown (U.S. Fish and Wildlife Service 2010, p. 27), the fire at North Bank/Soggy Bottoms suggest that low to moderate intensity fire can have short-term beneficial effects to the species. (USFWS, 2021b)

**Stressor:** CLIMATE CHANGE (USFWS, 2021b)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The likely impacts of climate change on rough popcornflower's ecological processes are closely connected to availability of water. Due to their shallow and ephemeral nature, wet swales in southwestern Oregon are particularly sensitive to increases in evaporation or reductions in rainfall. Strong climate variability is likely to persist in the Pacific Northwest, owing in part to the year-to-year and decade-to-decade climate variability associated with the Pacific Ocean (May et al. 2019, p. 1039). Periods of prolonged drought are projected to intersperse with years featuring heavy rainfall driven by powerful atmospheric rivers and strong El Niño winters (May et al. 2019. p. 1039). Even modest increases in warming could result in more runoff in winter and less in spring and summer, more winter flooding, and drier summer soils, thereby altering the seasonality and duration of wetland hydration (Field et al. 2017, p. 18). Climate change is expected to lead to increased variability in precipitation and to an increased loss of soil moisture due to evaporation and transpiration (Field et al. 2017, p. 18), which may exacerbate effects due to drought. Drought-mediated decreases in water depth and inundation periods could increase the frequency at which wetlands dry before rough popcornflower has completed their flowering and fruiting stages. Climate change could also cause temperatures to exceed those suitable for growth of the species (U.S. Fish and Wildlife Service 2010, p. 28). The expected negative effects of climate change on rough popcornflower include heavier winter rains and limited spring moisture, which would result in decreased fruit production. (USFWS, 2021b)

**Stressor:** Herbicide use
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species is likely affected by common herbicides. We have no knowledge the species is affected by Malathion or other general contaminants.

***Recovery***

**Reclassification Criteria:**
Criterion 1. At least 9 reserves, containing a minimum of 5,000 plants each, are protected and managed to assure their long-term survival. A reserve may be composed of one or more patches of rough popcornflower located within 1 km (0.6 mi) of each other. Criterion 2. A minimum of 500 m2 (5,382 ft2) is occupied by the rough popcornflower within each reserve. Occupied habitat should be determined by using a GPS device to delineate patches of plant, with the GPS data then uploaded into a GIS program to calculate total area. The maximum allowable location error is +/- 3 m (9.8 ft). For patches too small to be delineated accurately, a

GPS point location should be recorded along with a measurement of the occupied area. Criterion 3. A minimum of nine reserves, each meeting the requirements in Downlisting Criteria 1 and 2, are distributed with at least one reserve each in the Calapooya Creek and Yoncalla Creek recovery units, and a minimum of five reserves in the Sutherlin Creek recovery unit. The remaining two required reserves may be located within any of the natural recovery units, or elsewhere within the Lower North Umpqua River (1710030111), Calapooya Creek 6 (1710030301), and Elk Creek (1710030303) Hydrologic Unit Code 10 watersheds containing the recovery units. Criterion 4. Over a 5-year period with a minimum of 3 individual years of monitoring, demographic data indicate that at least seven of the nine reserves have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.

Recovery Priority Number: 8C

**Delisting Criteria:**
Criterion 1. At least 9 reserves will have established management plans or conservation agreements that include requirements for periodic monitoring and habitat maintenance. Habitat maintenance must prioritize the removal of woody vegetation and non-native invasive plants. Criterion 2. Seed accessions need to be collected from all 9 reserves and submitted for long-term storage at a local seed bank repository, with a minimum of 15,000 seeds per reserve stored for use in future augmentations or to re-establish each source population should one ever be extirpated. Criterion 3. Over a 10-year period with a minimum of 7 years of monitoring, demographic data indicate that populations in at least seven of the 9 recovery reserves have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.

**Recovery Actions:**

- Recovery Measures for Popcornflower: Evaluate the status of all existing populations. Conduct surveys to search for new populations. Rough popcornflower populations will have reserve status if protected and meet recovery criteria of 5,000 plants. Currently we consider 12 of 18 populations protected. Protect habitat to be included in reserves Provide educational opportunities for landowners/managers/general public Use of existing authorities and applicable regulations Evaluate techniques to reduce competition Evaluate techniques to reduce impacts of woody succession Implement control measures: Implement appropriate management to reduce competition and control woody plant succession Collect seeds from extant sites Produce and establish transplants Monitor existing populations Identify ecologically appropriate habitat Protect population introduction sites Produce and establish transplants Manage populations to promote viability Monitor new populations to determine viability Rank populations. Collect and bank seeds Evaluate population genetic diversity Evaluate pollinator availability Provide outreach services for reserve owners and the general public Evaluate the status of Plagiobothrys hirtus Inventories for new and known populations of popcornflower were conducted throughout the species range in 2005 and 2014 by ODA (K. Amsberry, Oregon Department of Agriculture, pers. comm. 2014). Documentation of the distribution and abundance of popcornflower began in 1995 and has continued annually at most sites in most years; the exceptions are 2001 for BLM populations and 2008 to 2011 for TNC populations (USFWS, 2016).

***Conservation Measures and Best Management Practices:***

- Recommendations: • Recommend downlisting to threatened. • In cooperation with partners, continue to manage rough popcornflower, utilizing best management practices for this conservation-reliant species. • Enhance protection for, and augment, existing populations in the Calapooya Recovery Unit by ensuring protection through formal conservation agreements, management plans or publicly established reserves for the Nonpareil and other populations in this Recovery Unit. • Reintroduce rough popcornflower into suitable habitat, particularly in locations that will contribute to meeting recovery criteria. • Continue to pursue protected/reserve status of wetland and wet-swale habitat conditions benefitting rough popcornflower. (USFWS, 2021a)
- Vegetation Control Mowing is a management tool utilized in rough popcornflower habitat to control competing native plant species and invasive species as well as to prepare for outplanting efforts. The Red Rock Park, Wilbur Mitigation Site, the Southside Swale, and the ODOT Yoncalla South populations are regularly mowed and rough popcornflower populations have expanded. A late summer and fall mowing at Red Rock Park was instrumental in combatting pennyroyal growth throughout much of the site and resulted in the largest ever plant count at this location (U.S. Fish and Wildlife Service 2020, p. 2) (Table 2). The Service funds mowing at the Southside Swale and the TNC Popcorn Swale Preserve to control native graminoids, non-native grass, and pennyroyal. In the last 15 years, the Service funded various non-native invasive plant and native vegetation management at four rough popcornflower populations (Southside Swale, Red Rock Park, TNC Popcorn Swale Preserve, and Orenco Ponds). The initial results were promising for the four sites, which saw increased population numbers. Non-native and native tree thinning conducted in 2004, at the TNC Popcorn Swale Preserve resulted in the highest number of rough popcornflower plants recorded for the preserve (three years post-treatment). Unfortunately, over time and without further vegetation management, the native and non-native plants (spreading rush and pennyroyal) responded more aggressively than rough popcornflower and encroached on much of the habitat formerly occupied by the plant, leading to an overall population decline. The population is slowly rebounding and TNC has plans to mow the property annually, with the expectation that plants will spread into previously occupied habitat. There is no planning to utilize grazing or prescribed burns for vegetation control at this time. Fencing Fencing can protect populations from anthropogenic disturbance. The Sutherlin Red Rock Park rough popcornflower population was regularly affected by horse trampling and used horse bedding was tossed into the wetland area supporting rough popcornflower. The plants were often smothered while competing with aggressive grass and pennyroyal. Since the area was enclosed with fencing and signed with information about rough popcornflower, the plants are no longer subject to trampling and no longer smothered with the bedding and thus are able to grow in denser patches, compete better with the grass and pennyroyal, and occupy more space than prior to fencing. Introductions and Augmentation In 1998, before the species was listed, rough popcornflower plants were introduced to three locations on BLM managed lands. Two of the populations were successful and are still extant. Rough popcornflower was also introduced to the Orenco Ponds mitigation site in 2011 on a parcel owned by Douglas County and at a privately held mitigation site in 2001 (ODOT Wilbur Mitigation Site). Rough popcornflower was also successfully augmented at the Douglas SWCD property, the ODOT Wilbur Mitigation Site, and a second ODOT mitigation site (Del Rio Mitigation Site). In 2016, a new population was introduced to the NBHMA (Soggy Bottoms Sister) and is a recovery level population (i.e., greater than 5,000 plants) (J. Brown, pers. comm. 2020). Stakeholder workshops Five stakeholder meetings occurred between 2004 and 2016, at which population and species needs, recovery targets, and habitat conservation were discussed. At the most recent meeting, the agencies and landowners indicated that the species was making significant progress in recovery. Conservation Agreements Collaboration among stakeholders plays an important role in species management. For example, a Management

Plan between the Service, City of Sutherlin, ODA, and Douglas SWCD was finalized to protect and maintain the populations on Sutherlin and Douglas SWCD properties in 2007. For information specific to each reserve and other populations of rough popcornflower, see Appendices 2 and 3.

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# SPECIES ACCOUNT: *Plagiobothrys strictus* (Calistoga allocarya)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An annual herb, 1-4 dm tall. White flowers appear March-April in a slender, curved inflorescence. (NatureServe, 2015)

**Historical Range**

Historically, three populations of Plagiobothrys strictus were documented within a 3-kilometer (2-mile) radius of Calistoga, Napa County, California. Prior to listing one population had been extirpated due to urbanization and agricultural land conversion (California Native Plant Society 2008a). (USFWS, 2010)

**Current Range**

The range extent covers a small area in Napa County, near Calistoga. The total range is only about 14 sq mi. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Plagiobothrys strictus is an annual herb in the Boraginaceae (borage family) (USFWS, 2010).

**Habitat Type**

Adult: Vernal pools (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits geyser- and hot spring-fed vernal pools and swales in meadows at 90-160 m elevation. Soils are clay or gravelly-clay loams. These pools contain high concentrations of boron and sulfates - substances that are toxic to most plants. Associated species include the rare Napa blue grass (Poa napensis). (NatureServe, 2015)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Population Growth Rate:**

Decline of 30-50% (NatureServe, 2015)

**Number of Populations:**

1 (USFWS, 2023)

**Population Size:**

297,963 plants (USFWS, 2023)

**Adaptability:**

Highly vulnerable due to annual habit and location in wetlands. (NatureServe, 2015)

**Population Narrative:**

Highly vulnerable due to annual habit and location in wetlands. Decline of 30-50% .Population size of this annual fluctuates from year to year. In some good years, as many as 6000 plants were reported. There are only 2 extant EO's ;there is a third, historical EO. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and individuals. Historically, there were only three known populations of both the Calistoga allocarya and the Napa bluegrass. The three populations of Calistoga allocarya were documented within a 3- kilometer (2-mile) radius of the city of Calistoga in Napa County, California; however, prior to listing one of the populations was extirpated due to urbanization and agricultural land conversion (Service 1997, pp. 55792, 55799). At the time of listing and our 2010 status review, there were two extant occurrences of Calistoga allocarya: one within a property that contains Myrtledale Hot Springs (hereafter referred to as the hot spring property) and the other on a property where the former Calistoga glider airport is located (hereafter referred to as the airport property) (Service 1997, p. 55792; Service 2010, p. 4). The combined area of the two remaining populations is less than 80 square meters (900 square feet) (CNPS 1990 as cited in Service 1997, p. 55792). The three historical occurrences of Napa bluegrass were also entirely within Napa County: two were on the hot spring property and the third was on the airport property (Service 2010, p. 4). Prior to listing, one of the Napa bluegrass populations on the hot spring property was extirpated (Department 1989, p. 2), and at the time of listing, two populations of Napa bluegrass, one at the hot spring property and one at the airport property, remained (Service 1997, p. 55799). The total area occupied by Napa bluegrass was estimated to be slightly greater than 100 square meters (1,100 square feet). In 1994, near the time of listing, the population of Calistoga allocarya at the airport property had approximately 5,000 plants within 180 square meters (2,000 square feet) (J. Ruygt 1996 as cited in Service 2010, p. 5). Surveys carried out prior to the last status review in 2009 estimated the airport property population size at between 3,310 and 5,000 individual plants (Service 2010, p. 6). Since the 2010 status review, the population of Calistoga allocarya at the airport property has been surveyed annually from 2013–2022, except for 2020 due to Covid restrictions (WyrickBrownworth et al. 2021, p. 3) (see specific counts in Table 1, below). The number of plants counted during these annual surveys is heavily influenced by the survey methods. Surveys consisting of weekly walk-throughs of the property from early spring to early summer (January – May) are preferable as identification of individuals is difficult later in the summer when the plants have already senesced and lost their flowerheads. In 2019, the total population for Calistoga allocarya equated to 297,963 plants within the airport property (Wyrick-Brownworth et al. 2021, p. 6). (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Commerical/Residential Development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The two Plagiobothrys strictus and Poa napensis populations exist on private land and could be developed. The airport property will be required by the City of Calistoga to be evaluated under the California Environmental Quality Act for the environmental effects to these species, and the evaluation reviewed by the California Department of Fish and Game, if and when any development should ever be proposed. According to the City of Calistoga Zoning Map, one property is zoned as Rural-residential and the former airport property is zoned Commercialairport (City of Calistoga 2003). Given that both species' population sizes are very small and restricted to two locations, development of these parcels could lead to the extinction of both species. The occurrences of the two species on the second private parcel (Myrtledale Hot Springs) in the City of Calistoga had been proposed for a new hospital (USFWS, 2010).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** the California and Federal Endangered Species Acts are the primary State and Federal laws, respectively, that provide protection for this species since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2010).

**Stressor:** Human activities (USFWS, 201)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Poa napensis individuals within the Myrtledale Hot Springs population could be lost to trampling should the number of hikers increase to the hot spring, the paved road is widened, or the property owner decides to alter the landscape causing the alteration of hydrology. Because the most recent observation of six Poa napensis individuals was in 2007 and conducted from

outside the property boundary (Occurrence #1, CNDDB 2009b), the risk of human activities may be even greater since a more accurate count of individuals does not exist currently. The former Calistoga airport parcel could be mowed or its hydrology could be altered presenting unknown magnitude of risk to the populations of either species since neither population has been thoroughly surveyed since 1996 (P. napensis Occurrence #3 and Plagiobothrys strictus Occurrence #3, CNDDB 2009a) (USFWS, 2010).

**Stressor:** Restricted Habitat, Range, and Few Numbers of Populations (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of geneitc variability/extinction
**Narrative:** Species in natural habitats face threats both from deterministic facts such as habitat loss, overexploitation, pollution, introduced species, and stochastic events associated with small population size. Such events may be of a demographic genetic or environmental nature, including catastrophes (World Conservation Monitoring Centre 1992). The estimated population size for Plagiobothrys strictus was over 5,000 individuals in 1994 (Occurrence # 3, CNDDB 2009a) and six plants in 2007 as observed from the edge of the second property boundary for Poa napensis (Occurrence #1, CNDDB 2009b). Both species' populations could be susceptible to extirpation from random events due to their restricted range. Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations (Menges 1991; Ellstrand and Elam 1993)

**Stressor:** Invasive plant species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Competition from invasive plant species poses a potential threat to both species. Exotic and/or invasive, weedy plant species reduce native plant diversity and diminish the habitat suitability for native species; this is particularly the case in sensitive habitats (G. Cooley, California Department of Fish and Game, pers. comm. 2008). The consistent pattern of heavy growth of nonnative grasses when not controlled by grazing or other management can 'smother' native plants, resulting in the subsequent crowding out, outcompeting, or overshadowing of native annuals. A common consequence of such heavy annual grass growth is development of thatch, which adds to the strong smothering effect by inhibiting annuals' germination and growth (Weiss et al. 2007) (USFWS, 2010).

**Stressor:** Climate Change and Drought (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these modeling results, Plagiobothrys strictus and Poa napensis plants could be unable to shift their range because of their isolated, small populations, whose growth depend upon particular

hydrological regimes, and the limited available, suitable habitat surrounding the two private parcels (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5C

**Recovery Actions:**

- No final recovery plan has been completed for these species (USFWS, 2010).
- Work with the landowners, the California Department of Fish and Game, the City of Calistoga, and California Native Plant Society to ensure the protection of all known populations of Plagiobothrys strictus and Poa napensis (USFWS, 2010).
- Work with the landowners, the California Department of Fish and Game, the City of Calistoga, and California Native Plant Society to ameliorate or eliminate any threats to Plagiobothrys strictus and Poa napensis from hydrological changes and from competition from nonnative plants (USFWS, 2010).
- Collect seeds from both species from both parcel sites and store them in Center for Plant Conservation certified botanic gardens to guard against extirpation of populations from chance catastrophic events (USFWS, 2010).
- Follow conservation measures and policies as stated in the 2007 Napa County General Plan Update (USFWS, 2010).
- Follow conservation measures and policies as stated in the 2003 City of Calistoga General Plan for sensitive plant species (USFWS, 2010).
- Conduct a population assessment for each species and continue monitoring over the next 5 years (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Calistoga allocarya and Napa bluegrass. Some of these recommendations were discussed in the last status review (Service 2010, p. 16) and remain valid. 1. Partner with private landowners, the California Department of Fish and Wildlife, the City of Calistoga, and the California Native Plant Society to ensure protection of all known populations of Calistoga allocarya and Napa bluegrass. 2. Work with the California Department of Fish and Wildlife, the City of Calistoga, and the California Native Plant Society to ameliorate or eliminate any threats to Calistoga allocarya and Napa bluegrass from hydrological changes and competition from invasive plants. 3. Collect seeds from both populations of both species and store them in Center for Plant Conservation certified botanic gardens to guard against extirpation from chance catastrophic events. 4. Follow policy CON-17 and associated conservation measures as stated in the Napa County General Plan to “Preserve and protect native grasslands, serpentine grasslands, mixed serpentine chaparral, and other sensitive biotic communities and habitats of limited distribution” (Napa County Department of Conservation, Development, and Planning 2009, p. CON-28). 5. Follow policies P1.1-3 and P1.1-4 and associated actions as stated in the Open Space and Conservation Element (Updated 2012) of the City of Calistoga General Plan to continue “efforts to identify and map biological resources on the gliderport property [airport property], which provides an important and unique habitat area within the city limits” and “explore the possibility of designating parcels as Natural Resource Preservation

Areas in areas of the city known to contain sensitive and unique species, in order to protect these resources” (City of Calistoga 2012, p. OSC-23). 6. Conduct a population assessment for each species and continue monitoring annually (USFWS, 2023)

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# SPECIES ACCOUNT: *Pogogyne nudiuscula* (Otay mesa-mint)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A small aromatic annual to 3 dm tall. Leaves are dark green, opposite, ovate to oblong and hairless. There are both axillary flowers and flowers at the top of the plant. The flowers are two-lipped, lavender and 11-14mm long. The fruit consists of small nutlets. Blooming is May-July. (NatureServe, 2015)

**Taxonomy**

Pogogyne nudiuscula is an annual herb in the mint family (Lamiaceae). As was mentioned in the description for Pogogyne abramsii, Howell (1931) considered all Pogogyne populations on Otay Mesa to be Pogogyne nudiuscula. Many of the older herbarium specimens that might be from the central mesas are labeled as Pogogyne nudiuscula, but are likely Pogogyne abramsii. Howell considered Pogogyne nudiuscula to be diagnosable from Pogogyne abramsii by having a glabrous (smooth) calyx and bract with a different morphology. This distinction is supported by current work (Jokerst 1993; McMillan unpublished data 1995), and the species is also diagnosable by usually having at least six flowers per node on the stem (USFWS, 1998).

**Historical Range**

Historically P. nudiuscula was found beyond Otay Mesa and occurred at 10 locations in southern San Diego County (Appendix 1). Herbarium records indicate that P. nudiuscula historically occurred further north near University Heights, Balboa Park, and Mission Valley (CNDDB 2010, Element Occurrence (EOs) 4, 9, and 10, respectively). Also, P. nudiuscula occurred in Mexico at the eastern edge of the city of Tijuana; however, it was believed to be extirpated from its Mexican locations prior to listing (Bauder and McMillan 1998, p. 65; USFWS 1993, p. 41385). Currently, P. nudiuscula is found at three locations on Otay Mesa: Otay Mesa West, Otay Mesa East, and Otay Mesa Northeast (Appendix 1). (USFWS, 2010)

**Current Range**

San Diego County, California; adjacent Baja California, Mexico. The range extent covers approximately 370 sq mi. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (NatureServe, 2015)

**Reproduction Narrative**

Adult: The family is primarily bee pollinated (Proctor & Yeo, 1973, p. 219).; (NatureServe, 2015). There is little documented information regarding pollination and seed dispersal mechanisms of P. nudiuscula. Observations in the field suggest that native syrphid flies (Syrphidae) and bee flies (Bombyliidae) are the most common pollinators (S. McMillan, EDAW pers. comm. 2010). Eurasian honeybees (Apidae) have also been seen pollinating P. nudiuscula (McMillan, pers. comm. 2010). Research on the similar species Pogogyne abramsii show that it is self-fertile but has greater seed set when cross-pollinated (Schiller et al. 2000, p. 393); further research is necessary to determine if this is the case for P. nudiuscula (USFWS, 2010).

**Habitat Type**

Adult: Vernal pools (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist

**Habitat Narrative**

Adult: Vernal pools (Smith & Berg, 1988). Moist flats in chaparral and coastal sage scrub (Munz, 1959). (NatureServe, 2015)

***Dispersal/Migration***

**Dispersal**

Adult: Moderate (USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: Zedler and Black (1992, p. 4) found that Pogogyne abramsii seeds germinated and grew from pellets of brush rabbits (Sylvilagus bachmani) and Audubon’s cottontail rabbits (S. auduboni) that were collected from vernal pools on Del Mar Mesa and Miramar Mesa. Zedler and Black (1992, p. 2) postulated that rabbit movement may be a potential vector for seed dispersal and genetic mixing of vernal pool obligate species including P. abramsii. They concluded that rabbit dispersal explains the “anamolous occurrence of vernal pool plants in newly excavated artificial pools (1992, p. 8).” Additionally, P. abramsii seeds float, which may result in limited dispersal opportunities when pools interconnect or lakes fill their basins in years of greater than average precipitation (Scheidlinger 1981, p. 54). It is possible that these dispersal mechanisms also apply to P. nudiuscula; however, data do not exist to support this assumption (USFWS, 2010).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Number of Populations:**

17 known and 2 questionable (USFWS, 2021)

**Population Size:**

1000 - 2500 individuals (NatureServe, 2015)

**Population Narrative:**

This wetland annual endemic is highly vulnerable. The long term trend is one of very rapid decline. Decline of >90% Population numbers for this annual are mostly unknown. CNDDB records only record a total of 1700 plants from all currenly known vernal pools. This is likely wildly off from reality. Of 9 EOs, at least five may be extirpated, and all but a few are severely threatened. (NatureServe, 2015). Based on current updates, there are 24 Pogogyne nudiuscula locations (Figure 2, Table 1): 17 are extant, 2 are presumed extant, 3 are historically extirpated, and 2 have questionable identification. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Urban development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Planned and ongoing development projects throughout Pogogyne nudiuscula's range were described as a primary threat in the listing rule (USFWS 1993, p. 41387). Urban development may result in: (1) the loss or damage of vernal pools by filling, grading, discing, leveling, and other activities; and (2) destruction of watersheds and the hydrology that support vernal pools; (3) isolation of vernal pools; (4) fragmentation of vernal pool systems. Destruction of watersheds and disruption of hydrological systems can create further impacts by creating barriers to dispersal, such that pollination and reproductive output may be inhibited (Schiller et al. 2000, p. 395). Potential means of seed dispersal (e.g., rabbits, floating seeds) (Zedler and Black 1992, p. 2) may also be impacted. Whenever development impacts vernal pools in a complex, some degree of fragmentation occurs within and among complexes. Because P. nudiuscula has specific habitat requirements (e.g., soil type, water depth), habitat degradation and alteration likely result in population decline (USFWS, 2010).

**Stressor:** Road projects (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road projects are a type of development that pose a threat to Pogogyne nudiuscula habitat at Otay Mesa West, Otay Mesa South, and Otay Mesa Northeast (Appendix 1). First, the listing rule identified State Route 125 construction on Otay Mesa as a project that could impact P. nudiuscula habitat. This project was completed and directly impacted vernal pool basins on the Otay Mesa Northeast occurrence (i.e., J29–30); however, vernal pools containing P. nudiuscula were avoided in one pool and seeds were collected and used to reestablish populations within their mitigation site which encompass J29–30 (Wynn, pers. obs. 2010). Second, the construction associated with Interstate 905 and Otay Mesa Road (J14) did not directly impact P. nudiuscula; however, indirect impacts in the future in the form of edge effects (see below) are possible. Third, State Route 11 (associated with a new U.S./Mexico border crossing) is planned southeast of State Route 125 on Otay Mesa. Though habitat is present, P. nudiuscula was not detected and Caltrans anticipates future potential edge effects to vernal pools if they are discovered in the area (USDOT and Caltrans 2008, p. 3.20-11–3.20-15). Edge effects to Pogogyne nudiuscula are evident as a result of road widening projects, creating outer bands of habitat distant from the center but immediately proximal to a different type of habitat, thus providing a different species composition and abundance divergent from the interior of the habitat (Forman and Gordon

1986, p. 108). These edges may allow P. nudiuscula to be in closer proximity to disturbed areas, which may facilitate the incursion of invasive, nonnative plants that can outcompete P. nudiuscula for space (see also Factor E discussion). Edge effects degrade extant interior habitat and create an island of the protected habitat/reserve through isolation and decrease the effective size and serviceability of a conservation area (Diamond and May 1976, pp. 228–252). Characteristics of habitat islands include less resistant habitat, more disturbed habitat, areas more susceptible to invasive species, areas with native species less resistant to disturbance, and higher seed immigration (Meyers and Bazely 2003, pp. 34-50). Further development of the roads mentioned above and surrounding areas would exacerbate these impacts (USFWS, 2010).

**Stressor:** Alteration of watershed (Hydrology) (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Although altered hydrology continues to be a threat to the species, the Service has been successful in ensuring implementation of measures to reduce this threat through section 7 consultations. For example, best management practices reduce the amount of runoff entering vernal pool watersheds, and restoration projects are designed to minimize water draining off impervious surfaces into vernal pool watersheds. However, the specific impact runoff has on Pogogyne nudiuscula is unknown because site specific monitoring has not been conducted. Preserved pools should be monitored for these runoff impacts to identify remediation where feasible and prevent further damage to vernal pool systems (USFWS, 2010).

**Stressor:** Compaction of erosion of soil (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Recent studies suggest that trampling associated with limited livestock grazing in the watershed may benefit some vernal pool species by increasing the inundation period of the pools through reduction of vegetation (particularly nonnative grass) in the watershed and compaction of the soil, which reduces infiltration (Marty 2005, p. 1630). Grazing may also increase the duration of vernal pool inundation by altering soil properties and modifying the rate of evapotranspiration from plants, thus counteracting the potential decrease in precipitation brought about by climate change to some degree (Pyke and Marty 2005, p. 1623). However, it is unknown if Pogogyne nudiuscula or vernal pool habitat in San Diego County benefit from low levels of trampling (USFWS, 2010)

**Stressor:** Off-Highway Vehicles (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Since listing, OHV continues to threaten Pogogyne nudiuscula, especially from recreational and Border Patrol activities (see Appendix 1). Installation and maintenance of fencing and signage are needed to help protect P. nudiuscula habitat from these impacts (USFWS, 2010).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2010)
**Exposure:**

**Response:**
**Consequence:** Loss of habitat
**Narrative:** Since listing in 1993, the Act is the primary law that provides protection for Pogogyne nudiuscula on Federal lands or in instances where there is a Federal nexus. Nearly all occurrences of P. nudiuscula are conserved under the San Diego's MSCP; however, coverage for this species and six other vernal pool species was removed from the City of San Diego Subarea Plan in April 2010. The Service accepted the City's relinquishment of coverage for vernal pool species; thus, P. nudiuscula is no longer a covered species under the subarea plan. However, the City of San Diego is currently working with the Service to revise and improve the management plan for P. nudiuscula under the MSCP. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. However, once a revised subarea plan is completed that provides coverage for P. nudiuscula, the Act will likely provide the most effective protection for the species (USFWS, 2010).

**Stressor:** Competition with invasive, nonnative plants (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Depending upon conditions, certain invasive, nonnative plants (such as the grasses discussed above) may replace Pogogyne nudiuscula. Therefore, we consider invasive, nonnative plants to be a continuing rangewide threat to all extant occurrences of P. nudiuscula (USFWS, 2010).

**Stressor:** Human access and disturbance effects (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Protective fencing is used in several conserved areas to protect vernal pool complexes and has been successful in significantly decreasing the impact of trampling and OHV use in the J29–30 vernal pool complex at Otay Mesa Northeast and J2 N/W/S vernal pool complex at Otay Mesa West (City of San Diego 1997, p. 299, 316). Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still threaten Pogogyne nudiuscula occurrences. The J32 complex in the Otay Mesa West occurrence may be the most severely impacted by trampling due to foot traffic by immigrants, transients, Border Patrol, and OHV use (City of San Diego 1997, p. 236). Fencing was installed and stolen (City of San Diego 1997, p. 236) indicating that monitoring is critical in reducing the impacts of human access and disturbance (USFWS, 2010).

**Stressor:** Fire and fire suppression activity (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Fire and fire suppression have been identified as a current potential threat at three of the four occurrences (vernal pool complexes J2, J2 N/W/S, J28, J14, and J29–30), with the exception of the Otay Mesa East occurrence. These areas may serve as a staging area in the event of a fire if defensible structures are developed in the vicinity (City of San Diego 1997) (USFWS, 2011).

**Stressor:** Drought and climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species, including Pogogyne nudiuscula or sites at this time. However, it is likely that impacts from existing threats could increase and new threats may arise. Sharing information between scientists, land managers, and decision makers will increase our ability to address and manage these threats (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Lack of geneitc variability/extinction
**Narrative:** Since listing, Pogogyne nudiuscula's range has decreased and there have been no new occurrences of the species. Therefore, restricted range and small population size continue to threaten P. nudiuscula at all of its occurrences (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2C

**Delisting Criteria:**
All the existing vernal pools and their watersheds identified in Appendix F and G of the Recovery Plan should be secured from further loss and degradation in a configuration that maintains habitat function and viability (as determined by prescribed research tasks) (USFWS, 2010).

Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 2010.

Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification (USFWS, 2010).

In the interest of ensuring these criteria are clearly articulated, we are amending the following clarification to the existing recovery plan. This amendment does not represent a revision of the delisting criteria, it simply provides more specific terminology. Delisting for the species covered by the 1998 recovery plan may be considered when the downlisting criteria have been met and: 1. All 74 geographic areas and associated vernal pool complexes as identified in Appendices F and G of the 1998 Recovery Plan under each of the specific management areas are protected and managed to ensure long-term viability. 2. The U.S. Fish and Wildlife Service must determine that the following factors are no longer present, or continue to adversely affect, Eryngium aristulatum var. parishii, Pogogyne abramsii, Pogogyne nudiuscula, Orcuttia californica, and the Riverside and San Diego fairy shrimp: ( 1) the present or threatened destruction, modification, or curtailment of their habitat range; (2) over utilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and ( 5) other natural and manmade factors affecting their continued existence (50 CFR 424.11). 3. Population trends for all seven taxa continue to be stable or increasing for 10 consecutive years after threats have been sufficiently ameliorated or managed ( completion of delisting criterion 2) prior to consideration for delisting. (USFWS, 2019)

**Recovery Actions:**

- This recovery criterion does not explicitly address any of the threat factors identified in the five factor analysis in the listing rule or in the above discussion. Moreover, achievement of this criterion as written is complicated by the fact that some pool basins within the complexes identified in Appendices F and G have been developed or preserved in accordance with provisions of regional HCPs since the completion of the Recovery Plan. However, working toward the goals in this criterion will reduce the threats discussed above under Factors A and E. Securing vernal pool complexes physically, legally, and ecologically would reduce threats posed by development (e.g., habitat loss and alterations of hydrology) and discussed under Factor A and E above. As discussed in Factor A, all of the extant occurrences of Pogogyne nudiuscula, are partially or completely conserved and those that are only partial conserved have been mitigated in another area of suitable habitat (Appendix 1). These protections generally extend to direct loss and not necessarily indirect loss of habitat through degradation. These lands are under conservation easements or protected in perpetuity, conserved through mitigation, or have some sort of protection from development (Appendix 1). Pools within these areas meet the criterion in the Recovery Plan as “secured legally” from further habitat loss. In the Recovery Plan, Appendix F lists the vernal pool occurrences that are necessary to stabilize the proposed and listed vernal pool species (USFWS 1998, p. F1). Appendix G of the Recovery Plan lists vernal pool occurrences identified as necessary to secure in order to reclassify the proposed and listed vernal pool species (USFWS 1998, p. G1). Appendix G broadly lists complex J (undescribed) and J–3 and J–22. Pogogyne nudiuscula is found throughout the J complex and portions of this complex have been conserved partially or fully and other areas have been extirpated and mitigated. Although some of these occurrences are considered secure from development, they are not all guaranteed monitoring or maintenance in perpetuity. Although it is not possible to specifically identify every complex in Appendices F and G of the Recovery Plan, development and impacts on complexes listed in Appendices F and G that contain P. nudiuscula should be avoided. Additionally, the Service is working towards conserving these complexes (USFWS, 2010.
- This criterion does not directly address any of the threats discussed above in the five-factor analysis. Rather, it uses a measure of stability that is not easily assessed for Pogogyne nudiuscula. As discussed in the abundance section of this 5-year review, the population numbers for P. nudiuscula are not easily measured. Because methods of measurement are not standardized and P. nudiuscula does not germinate every year, population abundance is not a good indicator for the species. However, restoration and management do provide a measure of protection against threats to the species. Additionally, the CFWO issues biological opinions associated with consultations under section 7 of the Act for Pogogyne nudiuscula. These opinions detail avoidance and minimization measures to prevent jeopardizing the species’ continued existence and can include restoration of P. nudiuscula habitat. Many of these opinions lead to successful restoration and protected populations of P. nudiuscula. Some pools are being restored and therefore meet the outlined goals of Criterion 3 in the Recovery Plan (USFWS, 2010).

- This criterion does not directly address any threats outlined in the five-factor analysis. In order to stabilize or increase the population, threats would have to be reduced. Reducing the threats discussed above in Factors A and E would help us provide the conditions needed to work toward the goal in this criterion, but vernal pool habitat has been reduced by human-induced conversion (Bauder and McMillan 1998, p. 66). As yet, however, it is difficult to assess the abundance of Pogogyne nudiuscula in the absence of standardized sampling methods and population trends for vernal pool annuals are often difficult to detect. Therefore, we are unable to address this criterion (USFWS, 2010).
- Support continued conservation, management, and monitoring of vernal pool habitat that supports Pogogyne nudiuscula, including monitoring of restored/enhanced habitat to determine if vernal pool restoration projects continue to be viable through time (e.g., artificial clay layer remains stable and supports adequate ponding) (USFWS, 2010).
- Work with the Otay Mesa Water District to address inundation of pools in J26 from the Otay Mesa water pump. Implement measures to ensure that water does not flow over the road and into the pools (USFWS, 2010).
- Conduct research to determine life history traits most vulnerable to threats discussed in the five factor analysis (USFWS, 2010).
- Develop a dynamic, threats based, species-specific recovery plan based on analysis of current knowledge of the species (USFWS, 2010).
- Establish a seed bank for Pogogyne nudiuscula according to Center for Plant Conservation guidelines (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below were identified in the 2010 status review (USFWS 2010, p. 29). The actions were intended to reduce threats to Pogogyne nudiuscula and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of P. nudiuscula will require cooperation and coordination with partners to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. We continue to believe the actions described in 2010 are relevant to the conservation of P. nudiuscula. 1. Support continued conservation and management of vernal pool habitat that supports Pogogyne nudiuscula, with emphasis on complexes that are not currently conserved and those within the Stockpen soil association. 2. Develop and implement a long-term monitoring program to describe population trends to better understand the resiliency of the different vernal pool complexes, including monitoring of restored and enhanced habitat to determine if vernal pool restoration projects continue to be viable through time (e.g., artificial clay layer remains stable and supports adequate ponding). 3. Identify a new conservation easement holder and land manager for the J26 complex. 4. Conduct research to determine life history traits most vulnerable to threats discussed in the five-factor analysis. 5. Develop a dynamic, threats based, species-specific recovery plan based on analysis of current knowledge of the species. (USFWS, 2021)

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# SPECIES ACCOUNT: *Polygala lewtonii* (Lewton's polygala)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/27/1993; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Polygala lewtonii is a relatively short-lived (5 to 10 year) perennial herb. Each plant produces one to several annual stems, which are spreading, upward-curving or erect, and are often branched. The leaves are small, sessile, rather succulent, broader toward the tip, and are borne upright, tending to overlap along the stem, like shingles. The normally opening flowers are in erect, loosely flowered racemes about 1.5 cm (Wunderlin et al. 1981) or 3.3 cm (Weekley 1996) long. The flowers are about 0.5 cm long and bright pink (Wunderlin et al. 1981) or purplish-red (Ward and Godfrey 1979). Two of the five sepals are enlarged and wing-like, between which the largest of the three petals forms a keel that ends in a tuft of finger-like projections (Ward and Godfrey 1979). The plant also produces two types of small, cleistogamous (non-sexual) flowers (L. Miller, Ocala NF, personal communication 1996,Weekley 1996). This species is closely related to the widespread P. polygama, which forms larger clumps and has a longer root, narrower leaves, and differently shaped wing sepals. It also has short branches that hug the ground, bearing inconspicuous self-pollinating flowers. (USFWS, 1999)

**Taxonomy**

This small herb was first collected near Frostproof, Florida by F. L. Lewton in 1894, and was named by J.K. Small (1898). The status of P. lewtonii as a distinct species was affirmed by Blake (1924) and James (1957). There have been no other taxonomic treatments of this species. (USFWS, 1999)

**Historical Range**

See current range.

**Current Range**

Lewton’s polygala occurs in sandhill (high pine) vegetation and Florida scrub of the Lake Wales and Mount Dora ridges in Highlands, Polk, Osceola, Orange, Lake, and Marion Counties of central Florida. (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollination/self-fertilization

**Lifespan**

Adult: relatively short-lived (5-10 year) (USFWS, 2019)

**Other Reproductive Information**

Adult: Lewton's polygala is amphicarpic, producing flowers and fruits above and below ground at different times (Menges and Weekley 2002). Lewton's polygala is one of only a few dozen amphicarpic angiosperms known worldwide. Amphicarpy is viewed as an adaptation for reproduction in uncertain habitats, for example, producing seeds underground where they have better chances of surviving fire (Cheplick and Quinn 1982) and are protected from herbivory (Menges and Weekley 2003). While self-fertilization occurs in Lewton's polygala, it appears to be a less-reliable mechanism for seed production than insect pollination. (USFWS, 2019)

**Reproduction Narrative**

Adult: Confusion has existed about whether P. lewtonii has cleistogamous flowers (James 1957, Wunderlin et al. 1981, Ward and Godfrey 1979, FWS 1996). More recently, Weekley (1996) and Miller (Ocala NF, personal communication 1996) confirmed the presence of two types of cleistogamous flowers. The first are solitary flowers in the axils of the lower leaves and the second are few-flowered racemes on underground rhizomes that are usually 5 to 15 cm long (Weekley 1996). Polygala lewtonii blooms from February to May with chasmogamous flowers dominating from February to April. Chasmogamous flowers have an average of four to six racemes per plant, though one extreme individual had 30 racemes (Weekley 1996). Each raceme has 20 to 25 flowers 85 to 100 percent of these set fruit. This high percentage of fruit set suggests that flowers self-pollinate when insect pollinators are not present. (USFWS, 1999).

**Habitat Type**

Adult: high pine and turkey oak barrens and transitional areas (USFWS, 1999)

**Environmental Specificity**

Adult: Narrow (USFWS, 1999)

**Habitat Narrative**

Adult: Polygala lewtonii is not strictly a scrub species and is found in widely scattered populations that frequently occur in transitional habitats between high pine and turkey oak barrens. P. lewtonii also occurs in both habitats (Wunderlin et al. 1981, Christman 1988). P. lewtonii depends on fire to maintain its habitat. It is found in sunny openings and often colonizes disturbed sites, such as roadsides and fire lanes. P. lewtonii’s preference for transitional habitats between high pine and turkey oak barrens suggests a preference for a burn frequency that is less frequent than high pine, but more frequent than turkey oak barrens. (USFWS, 1999)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

32 known occurrences (USFWS, 2021)

**Population Narrative:**

Lewton’s polygala is a perennial herb occurring in sandhill and scrub communities on the Lake Wales and Mount Dora Ridges in central Florida. Currently, there are an estimated 32 extant populations, though most are of unknown status due to lack of recent surveys, and 19 known or possibly extirpated populations (Table 1). Of the 32 extant populations, only 1 is stable to increasing, 6 are stable, 2 are declining, and 23 have an unknown status (Table 1). Although demographic and abundance data have been collected at 6 populations for approximately 20 years (Rosner-Katz 2020; Menges et al. 2021; Noland 2021), information on natural recruitment and age distribution is lacking for almost all populations, and trends cannot be determined. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of P. lewtonii, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the seral stages of high pine and xeric oak scrub to sup port P. lewtonii (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

**Delisting Criteria:**
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub or sand hill habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution and status of P. lewtonii. This species' distribution is somewhat questionable since individuals are easily overlooked. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)

- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, has become isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of P. lewtonii. (USFWS, 1999)
- Provide public information about P. lewtonii. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about P. lewtonii. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. lewtonii and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Conduct habitat restoration efforts at possibly extirpated sites on managed lands since Lewton’s polygala has a persistent soil seed bank and can reappear after fire/restoration. Lewton’s polygala 5-Year Review • Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support Lewton’s polygala. • Work with private landowners to acquire or conserve extant populations and restore sandhill and scrub habitat on these sites. • Strengthen ex situ conservation measures, including ensuring representation of Lewton’s polygala at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. Monitoring/Research Activities • Determine the condition of populations on private land whose status is currently unknown. • Expand level 3 (demographic) monitoring to more populations, such as ONF, Tiger Creek Preserve, and Bok Tower Gardens Pine Ridge Preserve, (as recommended by Menges et al. 2019) to determine trends and produce a population viability analysis. • Develop a standard methodology for monitoring Lewton’s polygala on conservation lands. • Initiate large-scale level 1 (distribution) and 2 (population size/condition) monitoring of Lewton’s polygala throughout the geographic range, including sites across a spectrum of time-since-fire and management regimes. • Compare germination rates of aboveground to belowground seeds and investigate the limitations to germination of aboveground seeds. • Determine the status of pollinator populations. (USFWS, 2021)

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# SPECIES ACCOUNT: *Polygala smallii* (Tiny polygala)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/19/1985; Southeast Region (R4)

**Physical Description**

Tiny polygala is an erect short-lived herbaceous species. Most plants germinate and die within one year. It forms a rosette and grows no more than 8 cm tall (Kennedy 1998). It has one to four, short, usually unbranched stems, and a well-developed, scented taproot. Its leaves are oblanceolate to lanceolate, from 1.5 to 5 cm long and 0.2 to 1.4 cm broad and occur in a basal rosette. The inflorescence is a cylindric raceme from 0.4 to 7 cm long and 0.5 to 1.8 cm thick and usually surpassed by the basal leaves (Kennedy 1998) The flowers have both functional stamens and pistils (perfect) and are not radially symmetrical (zygomorphic). The calyx has five sepals. The lateral pair is decurrent, large and petaloid. The corolla is a greenish-yellow color with three petals. The fruit is a thin-walled, two-celled capsule that splits down the center of the compartment. The seed is 1.2 to 1.4 mm long, with sparse rather short, stiff, appressed hairs (strigose). It also has a pair of aril-like outgrowths about half the length of the capsule (Gann and Bradley 1995, Smith and Ward 1976). (USFWS, 1999)

**Taxonomy**

J.K. Small first described tiny polygala as Polygala arenicola (Small 1905; type specimen at New York Botanical Garden, Small #1276). The specific epithet was later found to be invalid due to its prior use in 1903 by Gurke in describing another species of Polygala from southeast Africa (Smith and Ward 1976). In 1933, Small revived the segregate genus Pilostaxis Raf., and renamed tiny polygala Pilostaxis arenicola (Small) Small. The genus Pilostaxis has since fallen out of use, but represents the series Decurrentes, a natural group of seven species of Polygala found only in the southeastern U.S. (Smith and Ward 1976). Long and Lakela (1971) considered tiny polygala to be conspecific with Polygala nana (Michx.) DC., a species widely distributed in the southeastern U.S., but in 1976, Smith and Ward defended the specific status of tiny polygala, recognizing distinct characters of the seeds, lateral sepals, flower color, and leaves, and proposed Polygala smallii Smith and Ward as a nomen novum. Synonyms: Polygala arenicola Small, non Gurke; Pilostaxis arenicola (Small) Small; Polygala nana auct., non (Michx.) DC. (USFWS, 1999)

**Historical Range**

See Current Range. The historic distribution of tiny polygala to the north is uncertain; it possibly ranged as far north as central Brevard County, Florida. (USFWS, 1999)

**Current Range**

This species is known to occur on the Atlantic Coastal Ridge of southeast Florida, in Miami-Dade, Palm Beach, St. Lucie, and Martin Counties. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: ~ 180 days

**Other Reproductive Information**

Adult: Pollination in tiny polygala has not been observed in 2.5 years of monitoring (Kennedy 1998), or in 3 years of monthly life history monitoring (DERM 1994). Zomlefer (1991) reports that self-pollination may occur in species of Polygala which have a tuft of hairs on the sterile apical lobe of the stigma. These hairs catch pollen when the anthers dehisce, and, as the flower develops, these hairs may touch the receptive lobes of the stigma, transferring pollen. Tiny polygala has these hairs (Smith and Ward 1976) and may be selfpollinating. (USFWS, 1999)

**Reproduction Narrative**

Adult: Tiny polygala seedlings can be observed from late October through April, but are most typically seen from December to February (DERM 1996). Populations in Miami-Dade County appear to have two germination periods, a short one in June and a longer one between September and January (Kennedy 1998). Thus, seedlings can be germinating for 6 months out of the year, resulting in plants maturing at different times of the year, and overlapping generations within years. In populations, flowers appear throughour the year with a peak during summer. Also, seeds are produced year-round. Approximately one year following appearance of seedlings, plants show a marked reduction in condition, apparently allocating resources to flowering instead of growth or self-maintenance. By July, approximately 18 months after the first seedlings are observed, remaining plants senesce and die (DERM 1994). (USFWS, 1999)

**Habitat Type**

Adult: pine rockland, scrub, high pine, and open coastal spoil (USFWS, 1999)

**Habitat Vegetation or Surface Water Classification**

Adult: Terrestrial

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Tiny polygala occurs in four distinct habitats with similar characteristics: pine rockland, scrub, high pine, and open coastal spoil (Gann and Bradley 1995). All of these habitats are pyrogenic-extremely dry and prone to periodic natural fire. Pine rocklands historically burned every 2 to 15 years (Snyder et al. 1991). Sand pine scrub and sandhill burn less frequently, possibly every 10 to 50 years. (USFWS, 1999)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Tiny polygala seeds have paired, fleshy outgrowths, a typical adaptation to ant dispersal. ostermeijer (1989) reports that a similar species Polygala vulgaris L. is a specialist in ant dispersal. Also, ants have been observed carrying tiny polygala seeds to their nests on several occasions in Miami-Dade County (K. Bradley, Institute for Regional Conservation, personal communication 1996). The seeds have a bilobed aril attached to the caruncle. This bilobed aril was suggested by some to be an elaisome, a structure that contains lipids that are attractive to ants. Kennedy (1998) reports observing ants going into the flowers and removing and transporting seeds by the arils. After applying Sudan IV stain to the arils, she determined that they do not contain lipids; rather the arils appear to be hollow sacs. It is unclear why the ants are moving the seeds. (USFWS, 1999)

**Additional Life History Information**

Adult: Polygala smallii seeds are able to float in water for extended periods (over three weeks) (Kennedy 1998). The hairs on the seed coat appear to provide most of the buoyancy by trapping air. Since many of the sites where tiny polygala occurs are riparian or riverine and the seeds are buoyant, water may be the primary means of dispersal. After Hurricane Andrew, tiny polygala was found growing in areas where the soil was turned over or disturbed (ie. around uprooted fallen trees). A response to soil turnover may indicate a good seed bank. The seed banks probably occur in more habitat types than previously thought. (USFWS< 1999)

***Population Information and Trends***

**Number of Populations:**

6 (USFWS, 2021)

**Population Narrative:**

Polygala smallii is extant on a total of nine sites in Miami-Dade, Palm Beach, St. Lucie, and Martin Counties, with the highest density of sites located in southern Miami-Dade County (Wendelberger and Frances 2004; Woodmansee et al. 2007; Maschinski, pers. comm. 2010; Florida Natural Areas Inventory [FNAI] 2010a; Lange, pers. comm. 2017; Possley, pers. comm. 2017a). Clusters of sites are separated by an average of 38 miles (61 km). Eight of nine known occurrences are on publicly owned lands, and all the sites are currently being managed for conservation of P. smallii. The species is known to have been extirpated from at least five historical locations, including three in Miami-Dade County and single populations in Broward and St. Lucie Counties. Five sites are known from Miami-Dade County. These include the publicly owned Zoo Miami and adjacent U.S. Coast Guard (USCG) property, both located within the 2,100-acre Richmond pinelands (Lange, pers. comm. 2017; Possley, pers. comm. 2017). Possley pers. comm. (2017a) indicates the P. smallii population size within Zoo Miami has fluctuated from 13 to over 1,000 individuals in the past decade. The USCG site contains the largest population, which was estimated at over 10,000 plants during a 2008 survey (Lange, pers. comm. 2017; Possley, pers. comm. 2017a); no recent estimates are available for the species at this site. The three remaining P. smallii sites within Miami-Dade County each retain populations of ten individuals or less (Lange, pers. comm. 2017; Possley, pers. comm. 2017a). In Palm Beach County, the P. smallii abundance at two known locations fluctuates dramatically from year to year (Woodmansee et al. 2007). At Jupiter Ridge Natural Area, P. smallii abundance has fluctuated from 86 (2005) to 8 (2017) (Buck, pers. comm. 2017). The Limestone Creek Natural Area population has ranged from 3 to 60 since being discovered in 2002, with 5 encountered during 2017 (Woodmansee et al. 2007; Shearer, pers. comm. 2017). In southern Martin County, P. smallii is known to occur in Jonathan Dickinson State Park (JDSP). Surveys of the site have recorded between 6 and 64 individuals (Woodmansee et al. 2007; FNAI 2010a). Woodmansee et al. (2007) indicated that while the species appears to be in decline at JDSP, it is expected that plant numbers will increase in the long run, provided fires are administered. In St.

Lucie County, a small population (14 plants) of P. smallii occurs at the privately owned Lynn University (Woodmansee et al. 2007). (USFWS, 2019). Tiny polygala is currently known to occur in small populations located on tracts of suitable pine rockland and scrub habitat, mostly within publicly owned lands. Its limited distribution renders tiny polygala vulnerable to random natural or human-induced effects, including fire suppression and invasive exotic species. The most recent surveys for the species indicate that plants remain on ten sites within six populations (Table 1; Woodmansee et al. 2007; FNAI 2019; Black Finch 2020; Possley 2020; Rogers 2020; Rossmanith 2020; Shearer 2020; Law 2021). The majority of known tiny polygala populations occur on publicly owned lands that are managed for conservation. The one remaining population on private lands is managed for conservation under an HCP (Coral Reef Commons in the Richmond Pineland Complex; Service 2017). (USFWS, 2021)

***Threats and Stressors***

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

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

**Stressor:** Inadequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire suppression continues to affect Amorpha crenulata(Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous

species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

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

***Recovery***

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

Recovery Priority Number: 5C

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

2. A network of 6 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

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

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

**Recovery Actions:**
- Conduct surveys to determine distribution and status of Polygala smallii. Pine rocklands have been thoroughly surveyed in Miami-Dade County. Additional surveys in the historic range of this plant should be performed in the scrub, sandhill, and open coastal spoil of Broward, Palm Beach, Martin, and St. Lucie counties. Fire eliminates litter concealing species, it may kill seeds in the litter or soil surface, or it may enable seeds in the seed bank to germinate. For that reason, suitable habitats which did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)

- Protect and enhance existing populations. It is imperative for the recovery of this species that populations not be lost. (USFWS, 1999)
- Collect biological information important to species recovery. Determine population size and viability of all populations. Investigate the genetic relationship of distinct Polygala populations. (USFWS, 1999)
- Develop standardized monitoring. Collect existing and historical data, and place in a central location. Convene a meeting of all researchers. Monitor status and success of all populations; change management practices if so indicated.Monitor reintroduction success and modify procedures as necessary. (USFWS, 1999)
- Continue to provide public information about scrub, sandhill, and open coastal spoil habitat and its unique flora. (USFWS, 1999)
- Habitat-Level Recovery Actions: Continue to protect existing pine rockland, scrub, sandhill, and open coastal spoil plant habitats. Restore areas to suitable habitat. Research additional habitat relationships. Monitor sites with pine restoration programs to determine success. Continue implementation of the fire education program and modify as necessary, any fire management education program that has been developed. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Implement, continue, or increase habitat restoration efforts (exotic species removal and prescribed fire) at all sites with tiny polygala. • Survey extirpated sites and sites with unknown status annually to monitor for potential reappearance. • Continue to monitor extant populations annually. • Examine extant populations in Palm Beach, Martin, and St. Lucie Counties to determine if they are P. smallii or P. nana. • Conduct a comparative taxonomic study of P. smallii and P. nana using a multi-data approach (e.g., morphology, genetics, geography, ecological factors, etc.). • Survey potential habitat on privately owned sites if landowners will allow access. • If additional sites with tiny polygala are discovered, pursue conservation agreements and/or acquire land. Implement appropriate management for habitat restoration, particularly on sites with former tiny polygala populations. Any opportunities for purchase of properties with tiny polygala or better management under conservation easement should be pursued. • Additional partnerships should be promoted to share information, conduct collaborative research on pine rockland and scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Expand work on ex situ propagation and seed banks. • Conduct reintroduction feasibility studies and identify potential recipient sites. • Conduct additional demographic research including population assessments and tracking of habitat changes through time. Monitoring should assess population declines or increases and examine growth and establishment rates. • Conduct genetic studies to examine diversity among sites which may be declining due to isolation and reduced genetic drift. • Conduct research to evaluate reproductive biology. • Conduct research to examine the effects of growing season burns versus non-growing season burns on flowering, seed set, and establishment. • Conduct studies to examine the cyclic occurrence of tiny polygala and determine if select fire-return intervals can reestablish the species to historical locations. (USFWS, 2021)

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# SPECIES ACCOUNT: *Polygonella basiramia* (Wireweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/20/1987; Southeast Region (R4)

**Physical Description**

P. basiramia is a short-lived, perennial herb ( Hawkes, University of Pennsylvania, personal communication 1995). When vegetative, the plant consists entirely of basal, compressed stems with narrow, alternate leaves. Ocreae, the sheaths formed at stem nodes, are ciliate. Stems and leaves range in color from green to dark red; red coloration in the stems and leaves appears to be associated with individuals more exposed to sunlight and with older vegetative parts (although even seedlings are often red). As basal stems elongate, plants develop 1 to 46 slender, flowering, spike-like panicles as tall as 0.8 m (Hawkes and Menges 1995). This species is gynodioecious and plants have either only female flowers or hermaphroditic flowers. Individual flowers are small, white to slightly pink with 5 sepals (no petals), pink pistils, and black anthers. The gynoecium consists of 3 united carpels, 1-ovuled, ovary superior. Flowering occurs from the top spikelet downward on each stem. The fruit is a three-sided achene 1 to 3 mm in length. (USFWS, 1999) Wireweed Polygonella basiramia (= ciliata var. b.) (Small) Nesom and Bates Page 4-1149 Federal Status: Endangered (January 21, 1987) Critical Habitat: None Designated Florida Status: Endangered Figure 1. County distribution of wireweed. Recovery Plan Status: Revision (May 18, 1999) Geographic Coverage: Rangewide

**Taxonomy**

Originally named Delopyrum basiramia by Small in 1924 (Nesom and Bates 1984), this species was later thought to be a variety of Polygonella ciliata by Horton (1963). In 1984 Nesom and Bates recognized P. basiramia as a separate species. This species is commonly known as hairy or tufted wireweed. Polygonella basiramia is most closely related to P. ciliata and P. gracilis (Lewis and Crawford 1995). P. basiramia and P. ciliata are believed to have originated from P. gracilis, but whether they did so independently or from a single intermediate ancestral species is unknown. (USFWS, 1999)

**Historical Range**

See current range.

**Current Range**

Lake Wales, Winter Haven, and Bombing Range ridges in central peninsular Florida. It ranges from Lake Pierce in Polk County southward to Venus near the southern tip of the Lake Wales Ridge in Highlands County (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: short-lived (average 0.31 years) (USFWS, 2019)

**Breeding Season**

Adult: September to December (USFWS, 1999)

**Other Reproductive Information**

Adult: Wireweed is an obligate seeder: no adult plants survive fire, and all post-fire recruits derive from seed. Flowering begins in September and achenes are produced in late November and early December. Because flowering is sequential, beginning at the top of each spike-like panicle and moving downwards, flowers and achenes are present at the same time mid-autumn. Achenes drop readily from the plant and most fall by mid-January. (USFWS, 2019)

**Reproduction Narrative**

Adult: Polygonella basiramia is gynodioecious, with individual plants producing either pistillate (female) or perfect flowers (both sexes in a single flower). The ratio of female to hermaphroditic plants is 1:1 at Archbold Biological Station (Hawkes and Menges 1995). Pollinators of P. basiramia include small halictid bees, Perdita polygonellae (a bee specific to the genus Polygonella), Eumenidae wasps, and potentially Glabellula spp. (Bombyliidae) (M. Deyrup, Archbold Biological Station, personal communication 1995). Seed production by female plants greatly exceeds that of perfect plants, with an average of 217.8 seeds per stem for females, but only 32.1 for perfect plants. P. basiramia is an obligate seeder which means that no adult plants survive a fire event and all new growth is from seedlings. On a population level, the number of seeds produced by P. basiramia in one reproductive season is more than 30 times the average plant density, sufficient to replace existing populations if only 3 percent of seeds were able to germinate and survive. (USFWS, 1999)

**Habitat Type**

Adult: scrub/scrubby flatwoods

**Environmental Specificity**

Adult: Narrow (USFWS, 1999)

**Habitat Narrative**

Adult: Polygonella basiramia is most commonly found in rosemary scrub, also known as rosemary phase of sand pine scrub (Abrahamson et al. 1984, Menges and Kohfeldt 1995). At Archbold Biological Station, rosemary scrubs are found only on the higher ridges and knolls at 40 to 50 m in elevation, and are largely restricted to St. Lucie and Archbold soil types (Abrahamson et al. 1984), both well drained white sands (Carter et al. 1989). Outside Archbold Biological Station, rosemary scrubs are generally found on white sands and higher elevations (Hawkes, University of Pennsylvania, personal communication 1998). The fire cycle in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982, Myers 1990). Polygonella basiramia occupies open spaces or gaps between shrubs and can be found in abundance along sandy fire lanes, which provide similar habitat. (USFWS, 1999)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (inferred) (USFWS, 2019)

**Number of Populations:**

Based on FNAI data (2021) there were 65 EORs of wireweed considered extant and 4 EORs that were possibly extirpated (USFWS, 2021)

**Population Size:**

>1,000,000 total (USFWS, 2021)

**Population Narrative:**

The last FNAI Element Tracking Summary (FNAI 2015) reported 71 extant occurrences, 47 of which were on managed lands. This was a significant decrease (approximately 40 percent) from the 119 reported occurrences in the last 5-year status review (Service 2010d). At a larger scale, regional persistence of this species is dependent on landscape features and disturbance effects on metapopulation dynamics. Fire may expand or create the open sand gaps within a shrub matrix that support wireweed, but fire also kills established plants. Patchy fires may provide a balance, both creating suitable habitats and providing a fine-grained spatial landscape structure so wireweed can colonize those habitats. (USFWS, 2019). Wireweed occurs at nearly all (18 of 19) of the units of the Lake Wales Ridge Wildlife and Environmental Areas (LWRWEAs) (Menges et al. 2019): four areas at Avon Park Air Force Range (APAFR), three units of Lake Wales Ridge State Forest (LWRSF), three state parks (Highlands Hammock, Lake June in Winter, and Allen David Broussard Catfish Creek Preserve), two areas owned by The Nature Conservancy (Saddle Blanket Lakes, Tiger Creek Preserve), two tracts at Lake Wales Ridge National Wildlife Refuge, land owned by the Southwest Florida Water Management District, and at ABS. According to FNAI (2021), most occurrences (44 of 69 or 64 percent) are on protected areas, with 17 on LWRWEAs and many others on the LWRSF and various state parks (Table 1). Wireweed is a short-lived perennial plant, with widely varying population sizes (Bridges 2018). Population sizes vary annually and seasonally (Maliakal-Witt 2004). Because this species lacks a persistent seed bank, wireweed population recovery often experiences a delay for a few years after fire (which kills individual plants) until seeds disperse into the site (Book 2019). Most EORs (FNAI 2021; Table 1) do not specify the size of the occurrence, but those that do, range widely including populations in the thousands (Table 1). Christman (2006) reported about 1,082,433 plants throughout all occurrences evaluated, with the largest occurrence at 32,959 plants and the smallest consisting of one plant. More recent survey data (2014 to 2017) from APAFR (four EORs over nearly 1,500 acres) documented over 218,000 plants in four EORs (Bridges 2018). These surveys also documented an increase in the population sizes of wireweed over the last few years of surveys attributed to increased prescribed fire and hurricane damage opening overgrown areas (Bridges 2018). Bridges (2018) compared data collected from APAFR to Christman (2006) and estimated that APAFR accounted for about a third of known plants for wireweed and considered APAFR a “major stronghold” for the species. Population trends The recently reported 69 EORs (FNAI 2021) were a decline from the 119 extant EORs reported in the previous 5-year review (Service 2010), largely due to changes in FNAI definitions. Since 2010, FNAI has increased the area used to define an EOR. Due to insufficient research and monitoring of wireweed, there are insufficient data to evaluate the trends in populations. Detailed demographic data on individual populations (Level 3 monitoring, sensu Menges and Gordon 1996) was collected nearly two decades ago (Maliakal-Witt 2004) but has not been applied to questions of individual population persistence. Given the species’ life history (many populations, plants killed by fire, no persistent seed bank, and need for dispersal into burned areas), metapopulation analyses would be more appropriate than individual population viability analyses. FNAI ranks the viability (EORANK) of the EORs based on the size of the EOR general condition of the EOR, and the condition of the landscape surrounding the EOR. Based on FNAI data (2021) there were 65 EORs of wireweed considered extant and 4 EORs that were possibly extirpated (X?) (Table 1). A total of 35 EORs were considered viable (EORANK of A, AB, B, BC, or C), 5 EORs classified with uncertain viability (EORANK of BD or E), and 29 EORs were considered non-viable (EORANK of D, D?, H, X?) (Table 1, Figure 1). Of the 35 viable EORs, 30 (86 percent) occurred on protected lands (sites with habitat management or conservation mechanism) (Table 1, Figure 1). In contrast, the 29 non-viable EORs had few occurrences (9 EORs or 31 percent) on protected lands (Table 1, Figure 1). All 5 of the EORs with uncertain viability occurred on protected lands (Table 1, Figure 1). There is a need for surveys to determine the viability of these EORs. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time

(Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range.
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

**Stressor:** Climate Change (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There is currently no evidence of negative impacts to wireweed from climate change factors, but this could change in the future as Florida is vulnerable to changes in rainfall and temperatures expected due to climate change. While the strong influence of ocean currents make projecting regional climate in Florida difficult (Kirtman et al. 2017), estimates project that Florida's average annual temperatures will increase approximately 1.5 to 5.5°F (0.8 to 3.1°C) by 2050 and from 2.3 to 11.5°F (1.1 to 6.4°C) by 2100. The degree of change depends on the greenhouse gas emission rates and the region in Florida (Runkle et al. 2017). In addition, it is predicted that for Central Florida summer rainfall (wet season) will decrease up to 5 percent by 2050 (Runkle et al. 2017). Wireweed vital rates are sensitive to winter and spring rainfall (Maliakal-Witt 2004). Higher temperatures and changes in precipitation patterns could alter relative humidity levels and evapotranspiration rates, leading to the potential for more frequent and intense droughts and wildfire events. Scrub and sandhill species, in general, can tolerate drought conditions, but it is unclear how this anticipated future threat will fully affect species like wireweed or the ability to implement prescribed fire (Kupfer et al. 2020). In addition to changes in precipitation and temperatures patterns, there are also anticipated changes to the severity of tropical storms and hurricanes. Sweet et al. (2017) predicted a 20 percent increase in both rainfall rates and wind speeds near the center of storms due, in part, to higher sea surface temperatures. Sea-level rise is another anticipated consequence of climate change in Florida. Sea level rise will not cause direct impacts to the Central Florida ridges as is anticipated for coastal and low elevation areas. However, as sea level rises in coastal regions, development is likely to move inland, further increasing the threat of development in the higher elevation areas, such as the LWR (Volk et al. 2017). (USFWS, 2021)

**Stressor:** Non-native plant species (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Bahia grass (Paspalum notatum), cogon grass (Imperata cylindrica), and natal grass (Rhynchelytrum repens) invade scrub habitats and have negative effects through direct competition and by altering fire behavior. These species occur at numerous sites supporting wireweed. Because of wireweed's small stature and its preference for open conditions, exotic grasses are likely to have a serious negative effect on wireweed where they co-occur. At some protected site (USFWS, 2021).

**Stressor:** Off-road vehicles (ORVs) (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** ORV impacts have occurred to natural areas on the LWR and throughout Central Florida (Schultz et al. 1999). ORVs crush, uproot, and tear plants as they drive over them. Although most managed sites restrict ORV use where wireweed occurs, ORVs are a potential threat on unprotected sites. (USFWS, 2021)

**Stressor:** Ex situ measures (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Wireweed is lacking ex situ conservation measures for which imperiled and rare plants need. Bok Tower Gardens does not have wireweed in its' Center for Plant Conservation's National Collection of Endangered Species. However, wireweed may not be an ideal candidate for ex situ measures. Its short life span will create problems holding plants in a botanical garden setting. Seeds are stored at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. Seeds tend to germinate immediately and may not store well over long periods (although this has not been investigated). (USFWS, 2021)

***Recovery***

**Reclassification Criteria:**
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of P. basiramia, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support P. basiramia (USFWS, 1999)

4. When monitoring programs demonstrate that populations of P. basiramia on these sites support the appropriate numbers of self-sustaining populations, and those populations are

stable throughout the historic range of the species. Individuals growing opportunistically in unnatural areas, for example fire lanes, should be excluded from consideration when determining the status of this species. (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution status of Polygonella basiramia. This species' distribution is somewhat questionable for taxonomic reasons. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Though much of the basic biology and ecology of this species is understood, to effectively recover this species additional biological information is needed. (USFWS, 1999)
- Monitor existing populations of Polygonella basiramia. (USFWS, 1999)
- Provide public information about P. basiramia. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

**References**

USFWS. 2019. Amendment 1. Recovery Plan for Conradina brevifolia (short-leaved rosemary), Crotalaria avonensis (Avon Park harebells), Dicerandra christmanii (Garrett's mint), Dicerandra frutescens (scrub mint), Eryngium cuneifolium (snakeroot), Hypericum cumulicola (Highlands scrub hypericum), Liatris ohlingerae (scrub blazing star), Polygala lewtonii (Lewton's polygala), Polygonella basiramia (wireweed), Polygonella myriophylla (sandlace), Warea carteri (Carter's mustard), and Ziziphus celata (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

USFWS. 1999. Wireweed. Revised Recovery Plan (May 18, 1999). Pages 4-1149 to 4-1161, In: South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. URL: https://www.fws.gov/verobeach/MSRPPDFs/Wireweed

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USFWS. 2019. Amendment 1. Recovery Plan for Conradina brevifolia (short-leaved rosemary), Crotalaria avonensis (Avon Park harebells), Dicerandra christmanii (Garrett's mint), Dicerandra frutescens (scrub mint), Eryngium cuneifolium (snakeroot), Hypericum cumulicola (Highlands scrub hypericum), Liatris ohlingerae (scrub blazing star), Polygala lewtonii (Lewton's polygala), Polygonella basiramia (wireweed), Polygonella myriophylla (sandlace), Warea carteri (Carter's mustard), and Ziziphus celata (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

USFWS. 2021. Wireweed (Polygonella basiramia) 5-Year Review: Summary and Evaluation. South Atlantic-Gulf Region. Florida Ecological Services Field Office. Vero Beach, Florida. 21 pp.

# SPECIES ACCOUNT: *Polygonella myriophylla* (Sandlace)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/27/1993; Southeast Region (R4)

**Physical Description**

Polygonella myriophylla is a sprawling shrub that looks somewhat like the ornamental creeping juniper (Juniperus horizontalis). Its many branches zigzag along the ground and root at the nodes, forming low mats. The lower parts of the creeping branches have bark that cracks and partly separates in long, flat, interlacing strips. The short lateral branches end in flowering racemes. P. myriophylla has the sheathing leaf stipules (ocreae and ocreolae) typical of the jointweed family. The leaves are needle-like and are from 0.3 to 10.0 mm long. The small, white or cream colored flowers have white petallike sepals up to 3.4 mm long (Kral 1983). (USFWS, 1999)

**Taxonomy**

Sandlace is one of 11 species of North American Polygonella and one of three species of Polygonella that occur in scrub habitat in south Florida (Lewis and Crawford 1995). The sandlace was first collected in the early 1920s and was subsequently identified and named by Small (1924) as Dentoceras myriophylla. Horton (1963) combined two of Small’s genera with the genus Polygonella. P. myriophylla has been commonly called sandlace (Christman 1988), Small’s jointweed and woody wireweed (Wunderlin 1982). (USFWS, 1999)

**Historical Range**

See current range/distribution.

**Current Range**

In the Florida Counties of Orange, Osceola, Polk (Lake Wales Ridge), and Highlands (Lake Wales Ridge). (USFWS, 1999)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual; Vegetative (USFWS, 2019)

**Other Reproductive Information**

Adult: Sandlace reproduces sexually and vegetatively through the rooting of prostrate branches. Sandlace is killed by fire and will recolonize burned areas by seedling recruitment or clonal growth. Most obligate seeders in Florida scrub and sandhill, including both herbs (e.g., Highlands scrub hypericum, snakeroot, Lewton's polygala) and sub-shrubs (e.g., several species in the genus Dicerandra), recover quickly post-fire via seedling recruitment and often show dramatic aboveground population booms. In sandlace's preferred habitats, recommended FRIs range from 8 to 16 years for xeric scrubby flatwoods to 15 to 30 years for Florida rosemary scrub (Menges 2007). (USFWS, 2019)

**Reproduction Narrative**

Adult: Weekley and Menges (2003) confirmed that sandlace does not resprout after fire, but recolonizes burned areas from seed arriving from unburned areas, and perhaps by spreading from unburned areas. Pollinators of sandlace are genus-specific bees and likely a few varieties of wasps. Little is known about seed production and germination for this species, but seedlings do not survive in the vicinity of the mature plants, which are allelopathic, meaning they produce chemicals that inhibit the growth and survival of other nearby plants (Weidenhamer et al.1989). The major allelochemicals are gallic acid and hydroquinone (Weidenhamer and Romeo 2004).

**Habitat Type**

Adult: Scrub

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Sandlace occupies open, sandy areas within the scrub vegetation, and it appears to require fire or other disturbances that create or maintain these sandy gaps. This species is killed by fire, and reoccupies burned sites from seed (Pedro Quintana-Ascencio, University of Central Florida, pers. comm. 2004). Its abundance can easily be overestimated, because it tends to colonize disturbed areas along easily accessible road cuts and rights-of-way.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2019)

**Number of Populations:**

2 extant occurrences (USFWS, 2021)

**Population Size:**

~1.5 million (USFWS, 2021)

**Population Narrative:**

The previous FNAI Element Tracking Summary (FNAI 2015) reported 72 extant occurrences, 39 of which occurred on managed land. Thirty-three of 72 extant sandlace occurrences were located on private property where they had no protection from development and were unlikely to be appropriately managed. This was a significant decrease (approximately 36 percent) from the previous 5-year status review, which reported 113 extant occurrences. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated

are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of P. myriophylla, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the seral stage of xeric oak scrub communities to support P. myriophylla (USFWS, 1999)

4. When monitoring programs demonstrate that populations of P. myriophylla on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

**Delisting Criteria:**

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub or sand hill habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**

- Determine current distribution of P. myriophylla. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Though much of the basic biology and ecology of this species is understood, to recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of P. myriophylla. (USFWS, 1999)
- Provide public information about P. myriophylla. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native

Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where P. myriophylla is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. myriophylla and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the white-rayed pentachaeta. Some of these recommendations have already been discussed in our previous status review (Service 2010, p. 28): 1. Conduct surveys at known occurrences at least every five years to determine population trends and habitat changes. 2. Collect information on habitat preferences in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported the species at historic locations, particularly for white-rayed pentachaeta, which had a far greater range historically and likely more variability between sites. 3. Conduct surveys for potential locations in which to establish new populations. The surveys should also confirm that there is only a single population stretching across both the Triangle and Edgewood Park properties, rather than two or more populations separated by a quarter mile or more. 4. Work with partners and landowners to establish new populations. 5. Work with partners to produce and implement management plans specific to white-rayed pentachaeta conservation at each population site. (USFWS, 2021)

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# SPECIES ACCOUNT: *Potentilla hickmanii* (Hickman's potentilla)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A perennial herb from a woody taproot. Leaves are basal, with 4-7 pairs of deeply cleft leaflets. Stems are prostrate or decumbent, mostly 8-15 cm long. Slender flowering stems, 4-25 mm long, bearing yellow flowers arise from each stem. Blooms April-August. (NatureServe, 2015)

**Taxonomy**

Astragalus tener var. titi (Figure 4) was first collected by Mrs. Joseph Clemens in 1904. It was first described by Alice Eastwood as Astragalus titi based on those specimens collected by Clemens near Moss Beach, Monterey (Eastwood 1905). Eastwood named the plant A. titi in honor of Dr. F. H. Titus, who also collected specimens of this plant. Jepson (1936) considered these two taxa synonymous. Howell (1938) compared type specimens of A. tener and A. tener var. titi and confirmed two different plants, based on the low decumbent habit and smaller flowers of A. tener var. titi. Barneby (1950) published the name A. tener var. titi, noting differences from A. tener var. tener (alkali milk-vetch) in size of various flower parts, habitat, and geographic range. Astragalus tener var. tener is native to alkaline grass flats in the Central Valley, San Francisco Bay region, and the lower Salinas Valley (Barneby 1950). Additionally, crossing studies and enzyme electrophoresis concluded that A. tener var. titi is a valid taxon(Liston 1992) (USFWS, 2004).

**Historical Range**

Potentilla hickmanii was historically known from two general areas along the central coast of California: on the Monterey Peninsula in Monterey County, and in the Half Moon Bay area in San Mateo County. The type specimen was collected from the Monterey Peninsula “near the reservoir which supplies Pacific Grove” and described by Alice Eastwood in 1902. Several other collections were made from the Monterey Peninsula during the 1930s, but detail on specific locations is lacking. (USFWS, 2009)

**Current Range**

California endemic. One extant population in Monterey County. One large population exists in San Mateo County. The total range extent consists of 3 areas and about 9 sq. mi. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2004)

**Breeding Season**

Adult: Seeds are produced late in the season (USFWS, 2004).

**Reproduction Narrative**

Adult: Potentilla hickmanii has protogynous flowers with a stigma that is receptive to pollen before the pollen-bearing anthers open within the same flower (Jones and Stokes Associates 1996). This mechanism can reduce self-pollination and increase the possibility of outcrossing. It is also likely that some level of interpopulational genetic diversity exists (B. Ertter in litt. 1997). Seeds are produced late in the season. Plants may produce little to no seeds in drier years, especially among early-blooming flowers (Jones and Stokes Associates 1996, B. Ertter in litt. 1997). This lack of seed set might be due to the observed absence of pollinators during blooming time of dry years. Natural population increases appear during wet years, although these population increases may not occur during dry years (Doak et al. 2000). Additionally, recent greenhouse research indicates that some plants previously counted as up to five individuals may have been one single plant with a branched caudex (V. Yadon in litt. 2002). Research was conducted during 1998 and 1999 to explore environmental factors that limit seed production and establishment, and how a limitation might vary through the plants' flowering season (Doak et al. 2000). Evidence for pollen limitation of seed set was apparent and pollen augmentation also significantly reduced the probability of reproductive failure (Doak et al. 2000). Reproductive failure may exist if both pollinator visitation and pollen dispersal is low. Doak et al. (2000) observed only one pollinator in the 2-year study (i.e., a small beetle). Additionally, this research discovered that developed, mature seed was found significantly more frequently in plants that were within at least 50 centimeters (20 inches) of each other than in isolated plants (Doak et al. 2000). Potentilla hickmanii will grow and bloom year-round under cultivated conditions. However, cultivated flowers that bloom later in the year tend not to set seed (V. Yadon in litt. 2002). Plants with early flowers that were grown in a hot house set seed apparently without benefit of pollinators (V. Yadon in litt. 2002) (USFWS, 2004).

**Habitat Type**

Adult: coastal scrub/forest (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits coastal bluff scrub and closed-cone pine forest (Smith & Berg 1988). Freshwater marshes, seeps and streamlets in open forested areas near the coast, 0-75 m. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Population Growth Rate:**

Decline of 70-90%   (NatureServe, 2015)

**Number of Populations:**

2 (USFWS, 2025)

**Population Size:**

~7,500 total (USFWS, 2025)

**Population Narrative:**

Hickman's potentilla occurs in very small numbers (<80) at Indian Village in Monterey County and a larger population (~5,000) occurs on land managed by the Golden Gate National Recreation Area near Montara in San Mateo County.  (USFWS, 2020).  We consider there to be two extant populations of Hickman's potentilla: the Indian Village population in Monterey County, and the Montara population in San Mateo County. The Indian Village population occurs within approximately 0.33 acres (ac) of grassland habitat managed by the Del Monte Forest Conservancy (DMFC) bordered by Monterey pines, a golf course, and residential development. The Montara population consists of a series of subpopulations covering approximately 50 ac within coastal prairie, grassland, and coastal scrub habitat managed by the National Park Service (NPS) as part of the Golden Gate National Recreation Area (GGNRA). Since listing in 1998, the Indian Village population has been very small, with as few as eight individuals and as many as 79 following outplanting efforts (Table 1) (Service 2009, pp. 5-6; DMFC 2016, p. 5; Vaughan 2020, pers. com.; McCorkle 2020, pers. com.). Intermittent outplanting, weed management, and herbivore control since the early 1990s (Service 2009, p. 5) and as recently as 2015–2020 (DMFC 2016, entire; Vaughan 2020, pers. com.; Service 2020) likely aided in preventing the loss of the population. However, the population has recently declined to about 20 individuals from the high of 79 in 2020 (Table 1). Herbivory, mold, competition, and possibly drought have driven the recent mortality (Vaugh 2025, pers. com.). The Montara population occurs on land that was formerly owned by the Peninsula Open Space Trust and transferred to NPS in 2011 (NPS 2020). Monitoring and weed control have increased since NPS began management of the population. Monitoring by NPS since 2013 suggests that the average population size is closer to 6,500 individuals (Chasse et al 2024, pp. 45-48), in comparison to historical averages between 2,000 and 3,000 (Service 2009, p. 5). NPS is currently engaged in restoration activities to support and expand the existing patches of the Montara population through shrub removal (mostly Cotoneaster spp.) in conjunction with grassland restoration and Hickman's potentilla outplanting (E. Wrubel 2025, pers. com.). Seed propagated in park nurseries was used to outplant a total of 272 plants between 2022 and 2023 in or near known occupied habitat in this population (USFWS, 2025)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** current threats to the population at Pebble Beach, Monterey County, are relatively the same as at the time of listing. Because a second population has been discovered since the time of listing (Montara population in San Mateo County) and threats to the population are less than they are for the Pebble Beach, Monterey County, population, the threats to the species overall are less than they were at the time of listing. In addition, the Montara population has been transferred from private ownership to state and local agency ownership (CalTrans and Peninsula Open Space Trust ), and long-term plans are to transfer these lands to California State Parks and Golden Gate National Recreation Area, respectively. However, threats to the habitat remain at both locations, and include conversion of coastal terrace prairie habitat by native and nonnative species, alteration in hydrology, and recreation. The Pebble Beach population is threatened with extirpation from alteration and destruction of habitat because the size of coastal prairie where Potentilla hickmanii occurs is less than 0.25 ac (0.1 ha) and the number of individuals is so few; therefore, the remaining individuals may not be able to persist if the condition of the habitat continues to decline (USFWS, 2009).

**Stressor:** Predation (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Predation on Potentilla hickmanii by mule deer (Odocoileus hemonius) on the Pebble Beach population in Monterey County has been observed by Yadon (in litt. 1997) and others (Jones and Stokes Associates 1996). Since the time of listing, herbivory by voles (Microtus spp.), snails (various species), and slugs (various species) has also been observed on both vegetative and reproductive structures (Doak et al. 2000). As recently as 2008, Staub (in litt. 2008) noted that gophers (Thomomys sp.) and mice (various species) are likely affecting the population. With so few individuals comprising this population (11 individuals as of 2008), predation exacerbates the threat of stochastic extinction (see Factor E). We have also become aware that the Montara population in San Mateo County is within an area being grazed by cattle (CNDDB 2008). Cattle grazing may be either beneficial or deleterious to the species, depending on the intensity and duration. Cattle grazing may benefit the species by reducing competition from nonnative species. Too little grazing may allow nonnative species to outcompete Potentilla hickmanii, while too much grazing may result in predation or trampling of Potentilla hickmanii. We do not have specific information concerning the intensity or the overall impact of grazing that is occurring within this area (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** This species occurs within a portion of the Monterey Peninsula included in the California Coastal Zone. The Del Monte Forest Land Use Plan of 1984 was developed to comply with the Coastal Act's requirement that all counties prepare a plan for those portions of the Coastal Zone within their jurisdiction. Once the Del Monte Forest Land Use Plan was certified by the Coastal Commission, development permits within the Del Monte Forest coastal zone became the responsibility of the County of Monterey. The County of Monterey also has designated

certain areas, including where Potentilla hickmanii grows, as Environmentally Sensitive Habitat Areas. Protection of listed species through the California Coastal Act and local land use designations is dependent upon the discretion of the lead agency involved. Although no projects have been proposed for the site where Potentilla hickmanii grows, these state and local regulations may not protect the species from secondary impacts that occur from such threats as changes in hydrology in adjacent areas and the spread of nonnative species (USFWS, 2009).

**Stressor:** Competition with nonnative species (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the Monterey Peninsula site, at least five nonnative plant species occur within Potentilla hickmanii habitat. These include: hairgrass, various bromes, tall fescue, and ryegrass (Ferreira 1995, Yadon pers. comm. 2008). Nonnative grasses including Harding grass (Phalaris aquaticus) also occur at the Montara site. Several of these nonnative taxa are known to outcompete and displace native species in general (Bossard et al. 2000). To determine the effects of competition on Potentilla hickmanii, Doak compared the number of inflorescences and the number of flowers on Potentilla hickmanii seedlings within plots where surrounding vegetation was either clipped or unclipped; Potentilla hickmanii seedlings in the clipped plots produced more flowers and inflorescences than those in the unclipped plots (Doak et al. 2000). At the Montara site, pampasgrass was noted as being a potential threat to one colony of Potentilla hickmanii (Kramer 2008) (USFWS, 2009).

**Stressor:** Reproductive failure (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Reduced number of new plants
**Narrative:** At the time of listing, we discussed that reproductive failure was a concern, primarily because the Monterey Peninsula population had a very low number of new seedlings established over a 2- year period (Morosco 1997). In addition, low seed set had been observed by several biologists (Ertter in litt. 1997, Yadon in litt. 1997). Since the time of listing, Doak et al. (2000) compared seed set in flowers that were cross-pollinated by hand with those in a control group. Based on number of ovules, each flower has the potential to produce approximately 10 seeds; the researchers found that hand-pollinated flowers achieved a higher seed set than the control group (4.8 per flower compared to 3.2) (Doak et al. 2000). The lack of pollinators observed in the field has been put forth as a potential cause for low seed set by several observers (Yadon in litt. 1997, Ertter in litt. 1997, Doak et al. 2000) (USFWS, 2009).

**Stressor:** Small numbers of individuals and populations (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of genetic variability/extinction
**Narrative:** Conservation biology literature discusses that small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). Based on historical records, we believe that urban development and secondary impacts associated with such development has already reduced the distribution of this species in the two areas where it occurs. Indirect effects from urbanization in the watersheds include

changes in hydrology, changes in vegetation, and an increase in nonnative species. The effects of competition with nonnative species is most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). While any one of these factors may not be enough to threaten the survival of Potentilla hickmanii independently, its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of Potentilla hickmanii (USFWS, 2009).

**Stressor:** Alteration of fire frequency (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of listing, we discussed that alteration of fire frequency was a potential threat to all five taxa in the listing rule, due to fire suppression activities that increased on the Monterey Peninsula as development increased over time; we did not discuss specifically how reducing the frequency of fires in the area would affect Potentilla hickmanii. Although Potentilla hickmanii itself is associated with grassland habitats, the small meadow where it occurs is within an opening of Monterey pine forest. Without periodic fire, the pine forest would tend to expand in range over time and eventually shade out the habitat where Potentilla hickmanii occurs. Shading by Monterey pine was also noted as a threat to several colonies of Potentilla hickmanii at the Montara population (Kramer 2008). Based on current information, alteration of fire frequency may continue to be a threat to Potentilla hickmanii at both sites (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to Potentilla hickmanii at this time (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
At least five viable populations (i.e., populations that are stable or increasing based on a minimum of 10 years monitoring) occur in suitable habitat (addresses Listing Factors A and E). This criterion is relevant and up-to-date. This criterion has not been met. In addition to the two

populations known at the time of listing, one outplanting effort is underway at Point Lobos State Park (USFWS, 2009).

All five of the sites are on land that is protected from human-induced disturbance. Funds must be available for appropriate long-term management. As determined by research, protected habitat must be of adequate size (large enough to support a functioning ecosystem; e.g., species present to support seed dispersal and pollination, areas that support fluctuating distributions, areas that harbor suitable unoccupied habitat for population expansion) and configuration to ensure that ecosystem and community processes and associated species (e.g., hydrologic regime, food webs, pollinator fauna, forest meadow communities) are maintained, and that an adequate diversity of sites exist for population expansion and for colonization of new areas as microhabitat conditions change. One of these protected sites should be the Indian Village (Pebble Beach) population; another should be the Montara population in San Mateo County (addresses Listing Factors A and E). This criterion is relevant and up-to-date. This criterion has not been met (USFWS, 2009).

Surrounding vegetation has been managed for a reduction of nonnative plant species and nonnative snails and slugs. The populations should be adequately maintained, such that encroachments by nonnative plants and herbivorous predators (including deer) are not negatively affecting Potentilla hickmanii directly or indirectly (addresses Listing Factor C). Individuals have been caged at the Pebble Beach population, and this has reduced deer browse. However, additional management is needed to control nonnative species. This criterion is relevant and upto-date. This criterion has been partially met for one population (USFWS, 2009).

The populations have been appropriately managed to such a degree that monitoring has determined the populations are of adequate size, density, and number that the trend for each of the populations is projected to be stable or increasing in the future (addresses Listing Factors A and E). Population censusing and demographic studies have been conducted for the Pebble Beach population, but not in a manner that is able to detect long-term trends. This criterion is relevant and up-to-date. This criterion has not been met (USFWS, 2009).

A seed bank has been established at a recognized institution certified by the Center for Plant Conservation (addresses Listing Factor E). This criterion is relevant and up-to-date. This criterion has been partially met in the following way: a portion of seed from the Pebble Beach population that was previously collected for research is being stored at the University of California, Santa Cruz (UCSC); UCSC is not a Center for Plant Conservation affiliate. A small amount of seed was collected from the Montara population in 1995 by staff from the University of California, Berkeley (Jones and Stokes 1996); its current disposition is unknown (USFWS, 2009).

Recovery Priority Number: 5C

**Delisting Criteria:**
Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) maintaining and restoring habitat through control of nonnative grass species , and b) control of herbivory by deer and small mammals.  (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts; the Monterey Peninsula area should be further assessed for potential sites. Two additional, new populations are established and protected where appropriate. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. We expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Even though this is a perennial species, the aboveground portion is herbaceous and dies back each year, and thus responds to some extent like an annual species. Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

**Recovery Actions:**

- Work with Pebble Beach Company to evaluate current conditions and improve habitat conditions at the Pebble Beach site. Determine if additional measures can be taken to reduce threats from overwatering, invasive nonnative species, and herbivores (a portion of recovery tasks 1.4.3 and 2.3) (USFWS, 2009).
- Continue pollination ecology research initiated by Doak to determine if lack of pollinators is limiting seed set at the Pebble Beach site. Conduct research to identify pollinators at the Montara site and compare with those at Pebble Beach (a portion of recovery task 3.2.3) (USFWS, 2009).
- Seek additional sites for outplanting additional populations in Monterey and San Mateo Counties. State Park lands (aside from Point Lobos) may offer opportunities for outplanting (a portion of recovery task 4.2.3) (USFWS, 2009).
- Coordinate with Peninsula Open Space Trust to determine if management actions need to be taken to protect or enhance habitat for the species on lands they manage prior to transfer to Golden Gate National Recreation Area (GGNRA). Seek assurance from GGNRA that necessary management actions be continued (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-Year Review: 1. Continue management of herbivory and competing species at the Indian Village population. 2. Continue outplanting efforts at Indian Village to increase population size so that adequate natural recruitment is possible. 3. Restore associated native species to the Indian Village site to promote natural ecosystem processes. 4. Finalize and implement the National Park Service plan to manage and restore habitat and outplant Hickman’s potentilla at the Montara population. 5. Resurvey and monitor the Point Lobos introduction sites. 6. Evaluate additional introduction sites in San Mateo and Monterey Counties. 7. Continue seed banking efforts until adequate seed from both populations have been stored. (USFWS, 2020)
- RECOMMENDATIONS FOR FUTURE ACTIONS: We recommend the following actions: 1. Establish outplanting and management program at Indian Village. Management should include grassland restoration, competitive vegetation control, and herbivory control. 2. Expand Montara populations to new areas of suitable habitat and increase abundance of existing but small patches. 3. Reintroduce Hickman’s potentilla to Point Lobos with adequate funding for a sustained management program. 4. Develop a common garden experiment and genetic study to assess whether seed from

each population should be kept separate or mixed. 5. Identify additional introduction sites in San Mateo and Monterey Counties. 6. Continue seed banking efforts until adequate seed from both populations have been stored (USFWS, 2025)

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# SPECIES ACCOUNT: *Prunus geniculata* (Scrub plum)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/20/1987; Southeast Region (R4)

**Physical Description**

The scrub plum is a heavily branched, broad-crowned shrub that can reach 2 m in height, although 0.5 m may be more typical at sites with frequent fires. It grows from gnarled, half-buried trunks and spreads by sucker shoots. Its young twigs are strongly geniculate (zig-zag shaped), while its lateral branches are either short, stubby, spur shoots bearing leaves and flowers, or are strongly tapering and spine-like. The bark of old stems is thin, gray, usually lichen-encrusted, and forms small rectangular or square plates. The bark of new shoots is lustrous reddish-brown or purplish and smooth. The scrub plum's leaves are crowded on the spur shoots (an arrangement typical of the Rosaceae family) and are widely spaced on the normal shoots. The stipules are linear-subulate, roughly 5 mm long, green, and pectinately fringed at the margins with reddish glands. The leaf blades are ovate to obovate or elliptic, 1 to 3 cm long, short-acuminate, and serrulate with gland-tipped teeth. The leaf base is rounded or broadly cuneate. The leaf stalk is a third to half as long as the blade. The scrub plum has small, fragrant flowers that are 11 to 13 mm across when open. Like the leaves, flowers found on the spur shoots are rather crowded, while those found on the regular shoots or the spine bases are spaced further apart. The pedicels extend only slightly beyond the bud scales, so the flowers give the appearance of being sessile. The flowers are radially symmetrical with a 3 mm long hypanthium (the cup-shaped structure formed by the united portions of the bases of the sepals, petals, and stamens). The 5 calyx lobes are radially symmetrical, spreading to ascending triangular with acute apices, sparsely ciliate on the margins, reddish or green, with the bottom surfaces smooth and the upper surfaces white-tomentose. The 5 petals are white, spreading, and about 5 mm long. The petal blades are ovate to obovate with rounded tips and attenuated bases ending in short, ciliate-margined claws. The stamens are numerous, roughly 0.5 mm long, and borne on the rim of the hypanthium. The fruit of the scrub plum is an ovoid or ellipsoidal drupe, 12 to 25 mm long, and dull reddish in color. It has a thin, bitter flesh and a slightly flattened seed. (USFWS, 1999)

**Taxonomy**

Prunus geniculata was first described by Roland M. Harper in 1911 (Harper 1911). There has been no additional treatment of this species. The common name "scrub plum" was first used by Small (Small 1933). (USFWS, 1999)

**Historical Range**

See current range/distribution.

**Current Range**

In Florida, the range includes Lake County, west and southwest of Lake Apopka; the southwest and northwest corners of Orange and Osceola counties, respectively; and Polk and Highlands counties, from the City of Lake Wales south to the Highlands County/Glades County border. (USFWS, 2009)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Scrub plum is a rare plant with a very narrow range and small, widely scattered populations. It frequently forms small colonies of several plants but may grow as solitary individuals (unpublished FNAI data). It prefers fairly open areas without a dense canopy, but older plants are able to survive in dense shade (Schultz, pers. obs.). Scrub plum's life history has not been reported in the literature. Many birds, rodents and other mammals are known to be fond of plum fruit and are probably responsible for the dissemination of the species (Van Dersal, 1938). Gopher tortoise (Gopherus polyphemus) could also be a vector. Kral (1983) states that P. geniculata respond vigorously to fire disturbance and historically was probably fire maintained due to its presence in frequently burned sandhills.; ASEXUAL; Perfect; Predominantly outcrossing; SEXUAL; BIOTIC; Birds; Mammals; BIOTIC; Hymenoptera; Insects, other; (NatureServe, 2015). From the various research efforts, we now know that scrub plum: (1) has a rare breeding system characterized by the presence of male and bisexual flowers on the same plant, (2) is partially self-incompatible and that inbreeding depression is high in self-compatible individuals, and (3) experiences high rates of fruit loss due to abortion and pre-dispersal predation. Recent research has also confirmed that scrub plum is long-lived and experiences low mortality, and populations persist for long periods in the absence of fire (Pace-Aldana et al. 2006; Menges et al. 2008; C. Weekley, Archbold Biological Station, personal communication, 2009). Current information also supports previous reports that this species is a strong postburn resprouter (Weekley et al. 2007, Weekley and Menges 2003, Menges et al. 2007) and that recruitment is low (Service 1999; Weekley and Menges 2003, 2007). Weekley and Menges (2008) are currently evaluating the effects of various land management treatments on a number scrubendemic plants, including scrub plum (USFWS, 2009).

**Habitat Type**

Adult: Turkey oak sandhill and evergeen oak-sand pine (USFWS, 2009)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2009)

**Environmental Specificity**

Adult: Narrow/specialist (USFWS, 2009)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from USFWS, 2009)

**Site Fidelity**

Adult: High (inferred from USFWS, 2009)

**Habitat Narrative**

Adult: Species inhabits deep, yellow sands of longleaf pine-turkey oak sandhill and white, excessively leached, wind-deposited soils of evergreen scrub oak-sand pine scrub (NatureServe, 2015). High site fidelity and ecological integrity of the population as well as low tolerance range are inferred based on the specific habitat requirements of this species.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Scrub plum's life history has not been reported in the literature. Many birds, rodents and other mammals are known to be fond of plum fruit and are probably responsible for the dissemination of the species (Van Dersal, 1938). Gopher tortoise (Gopherus polyphemus) could also be a vector (USFWS, 2009).

***Population Information and Trends***

**Number of Populations:**

64 (USFWS, 2023)

**Population Size:**

2500 - 10,000 individuals (USFWS, 2009)

**Population Narrative:**

Responds vigorously to fire disturbance; cannot withstand soil disturbance of shade. Sometimes common, but usually only a few individuals at a site (NatureServe, 2015). FNAI updated its records for scrub plum in the 6 summer of 2008 and confirmed 83 extant populations. These 83 populations contained from 1 to 10,200 plants (A. Johnson, Florida Natural Areas Inventory, personal communication, 2009). Forty-five populations contained 10 or more plants (USFWS, 2009). Prunus geniculata is a long-lived, heavily branched shrub, that thrives in fire-maintained scrub habitat native to ancient ridges in central Florida. There are estimated to be 64 extant populations in 5 counties. Of these populations, 40 are found on conservation lands and 13 of those had their conditions ranked as excellent or good on when last observed. There were 51 populations that are either found on private lands or have lower ranked conditions. Additionally, only six populations on the conservation lands have an estimated size over 100 individuals (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Fire Suppression (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The most pervasive threat to scrub plum on public land is habitat degradation due to fire suppression. Most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida’s fire-adapted ecosystems (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2007; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of scrub plum habitat in some areas (USFWS, 2009).

**Stressor:** Urban development (USFWS, 2009)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Scrub plum that occur on non-conservation private lands also are vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. Scrub plum on each private parcel is vulnerable to this threat at any time. Several populations are located in areas previously platted for residential development and these populations are at greatest risk, especially when economic conditions improve and residential construction resumes at is historic pace. One small population is imminently threatened by land clearing for commercial development. In 2006, the Service issued an incidental take permit for two fossorial skinks on about 45 acres in west-central Lake County. Several hundred scrub plum plants were also found on this parcel along with six other federally listed plants (Service 2005). The entire parcel has not yet been developed but as land clearing proceeds individual plants will be destroyed (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** On private properties, Federal or State laws provide little protection for scrub plum. Since the majority of extant scrub plum populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species (USFWS, 2009).

**Stressor:** Low seed viability (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of genetic diversity
**Narrative:** Scrub plum produce few viable seeds and recruitment is extremely low (Weekley et al. 2007; B. Pace-Aldana, TNC, personal communication, 2008). Loss of seeds due to inbreeding depression reduces the number of germinable seeds. These effects may be exacerbated by habitat fragmentation and fire exclusion (C. Weekley, Archbold Biological Station, personal communication, 2009) (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Applicable to the South Florida populations: 1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years. (USFWS, 1999)

Applicable to the South Florida populations: 2. When these populations, within the historic range of P. geniculata are adequately protected from further habitat loss, degradation, and fire suppression. (USFWS, 1999)

Applicable to the South Florida populations: 3. When these sites are managed to maintain the high pine and xeric oak scrub communities to support P. geniculata; (USFWS, 1999)

Applicable to the South Florida populations: 4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 1999)

Applicable to the entire species range: The 1996 recovery plan lists four criteria necessary to reclassify the scrub plum from endangered to threatened status: (1) there are eight populations at four sites; (2) at least 10 years of demographic monitoring is conducted at one of these locations; (3) scrub plum is monitored at all locations; and (4) there must be protected locations in Highlands, Polk, and Lake counties. (USFWS, 1996)

Recovery Priority Number: 2

**Delisting Criteria:**
Applicable to the entire species range: To delist the scrub plum, 20 populations must be present at 5 sites and there must be 10 additional years of monitoring. (USFWS, 1996).

**Recovery Actions:**

- S1. Determine current distribution of P. geniculata. Conduct surveys for P. geniculata. Conduct surveys for P. geniculata. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- S3. Conduct research on life history characteristics of P. geniculata. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- S4. Monitor existing populations of P. geniculata. Develop monitoring protocol to assess population trends for P. geniculata. Develop a quantitative description of the population structure of P. geniculata. (USFWS, 1999)
- S5. Provide public information about P. geniculata. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. geniculata and other rare species requires a self sustaining, secure number of natural populations. (USFWS, 1999)
- H1. Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Both urbanization and fire suppression have decreased the available habitat. To date, there are six protected sites for P. geniculata in Polk and Highlands counties. (USFWS, 1999)

- H2. Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. (USFWS, 1999)
- H3. Conduct habitat-level research projects. Study the response of P. geniculata to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. (USFWS, 1999)
- H4. Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, exotic plant control, etc., on the habitats where P. geniculata occurs. (USFWS, 1999)
- H5. Provide public information about scrub and its unique biota. Educational efforts, especially those conducted by Archbold Biological Station, have been successful. Without these successful efforts, the Lake Wales Ridge NWR would not have been created. Florida's system of biological preserves depends on a broad base of public understanding and support for its funding and future success. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, and the Florida Park Service, the Florida Division of Forestry, the South Florida Water Management District, the Florida Native Plant Society, and local garden clubs are crucial in increasing public appreciation of scrub and high pine communities, and their associated plant species. The Arbuckle Appreciation Day sponsored by the Florida Division of Forestry has been especially successful. (USFWS, 1999)
- Recommendation for Future Action from 2009 5-Year Review: Revise the recovery criteria to establish measurable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, the demographic performance levels/rates that should be met, and the timeframe within which these levels/rates should be attained/maintained (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Continue demographic monitoring on the Carter Creek tract of the LWRNWR and reinitiate demographic monitoring on TNC's Tiger Creek and Longleaf Pine Preserves. Conduct Level 2 (see Menges and Gordon 1996) monitoring on multiple sites using populations in different habitats and with different management regimes (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Conduct a rangewide survey of genetic diversity in scrub plum. Such a survey could help in identifying populations that might be targeted for acquisition or included as a propagule source for creation of new populations on sites undergoing restoration (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Evaluate breeding system to identify S-locus and assay S-allele diversity within populations to assess the degree of self-incompatibility and role of inbreeding depression in seed viability (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Implement management activities on public lands that contain scrub plum, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Purchase or otherwise protect large scrub plum populations on unprotected lands. Protection should target scrub plum populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Explore opportunities to encourage landowners to conserve and manage property known to contain this species

(USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence wherever additional opportunities exist when engaging with agency management personnel. • Encourage landowners whose populations occur on conservation lands to monitor occupied habitat for increased data of long-term species trends. • Initiate long-term monitoring programs for populations with highest viability potential on conservation lands to discern long-term species trends (USFWS, 2023).

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# SPECIES ACCOUNT: *Pseudobahia bahiifolia* (Hartweg's golden sunburst)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An annual herb, about 6-15 cm tall, covered throughout with white, wooly hairs. Flower heads (March or April) are bright yellow, and are borne singly at the ends of the branches. (NatureServe, 2015)

**Historical Range**

The historical distribution of Pseudobahia bahiifolia is not known specifically but is thought to have spread approximately 200 miles along the eastern San Joaquin valley and foothills from Stanislaus County in the south to Yuba County in the Sacramento Valley to the north (Stebbins 1991). The distribution once extended north to Yuba County in the Sacramento Valley, based on the 1847 type collections of Karl Hartweg; however, these occurrences are now extirpated (Stebbins 1991). (USFWS 2007)

**Current Range**

The current distribution of the majority of P. bahiifolia occurs in two isolated clusters, including six extant occurrences near Friant along both sides of the San Joaquin River in high pumice content soils (Fresno and Madera Counties) and six occurrences near Cooperstown in Stanislaus County. Pseudobahia bahiifolia grows in loam or sandy loam soil associated with Amador and Pentz series (Stanislaus County), Rocklin series (Fresno and Madera County), Amador and Hornitos soils (Merced County) (Stebbins 1991). (USFWS, 2007)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowerind and fruiting occur in March-April (NatureServe, 2015).

**Reproduction Narrative**

Adult: Grazing levels must be reduced during flowering and fruiting (March-April). Overgrazing during this period has been documented to be detrimental. The greatest threat to this species is destruction of habitat by ag, development and heavy grazing (NatureServe, 2015).

**Habitat Type**

Adult: Grasslands/woodlands (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits non-native grasslands and occasionally grassland-blue oak woodland community ecotones in the Central Valley of California. The composition of the prehistoric grassland communities in this area is unknown; the communities have long-since become dominated by exotic grasses. P. bahiifolia generally occurs in areas with Mima mound topography: small mounds (30 cm to 2 m in height) interspersed with shallow basins that may form vernal pools. The plants nearly always occur on north-northeast facing mound slopes, preferentially on the upper slopes where grass cover is minimal. Plant can also occur along shady creeks or the margins of vernal pools. Plant distribution is closely correlated with certain soil types; prefers highly acidic, shallow soils derived from rhyolitic tuff. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

23 presumed extant (USFWS, 2023)

**Population Size:**

10,000 to >1,000,000 individuals (USFWS, 2023)

**Population Narrative:**

About 32,000 total plants in 1990 (Stebbins 1991 Status Survey, cited in USFWS 1997). 16 Populations (USFWS 1997). (NatureServe, 2015). The current species distribution and abundance of Hartweg's golden sunburst is similar to what we described in our final listing rule and 2007 status review (Service 1997, p. 5543; Service 2007, p. 2). The known occurrences of Hartweg's golden sunburst are concentrated in the eastern San Joaquin Valley in Stanislaus, Madera, Merced, and Fresno Counties (Table 1; Service 2007, p. 6). At the time of the last 5-year review, the distribution of the majority of Hartweg's golden sunburst occurred in two isolated clusters, including six extant occurrences near the community of Friant along both sides of the San Joaquin River in high pumice content soils (Fresno and Madera Counties) and six extant occurrences near Cooperstown in Stanislaus County (Service 2007, p. 6). The three occurrences (Diversity Database occurrence numbers 6, 7, and 17) near Cooperstown house the largest known populations of Hartweg's golden sunburst and have measured at over 10,000 individual plants (Diversity Database 2023). Currently, there are six known Diversity Database occurrences of Hartweg's golden sunburst that have had over 1,000 individuals estimated or counted during a survey (Vollmar Consulting 2010, pp. 64, 119). In addition, five Diversity Database occurrences of Hartweg's golden sunburst were discovered since the 2007 status review. Two of the new occurrences (Diversity Database occurrences 37 and 38) contained over 1,000 individuals when they were discovered; (Vollmar Consulting 2010, pp. 1, 18; Diversity Database 2023). Abundance of Hartweg's golden sunburst fluctuates greatly from year to year due to weather conditions such as rainfall. The surveys completed since the previous 5-year review do not alter our understanding of the species' current distribution or abundance and population estimates or trends have not been determined (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Residential development (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Agricultural conversion (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Flooding (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Protected occurrences (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Overgrazing and trampling (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:**

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2007)
**Exposure:**

**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Non-native plants (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Road maintenance and widening (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Transmission line maintenance (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:**

**Stressor:** Drought (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Small population size (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of geneitc variability
**Narrative:**

***Recovery***

**Recovery Actions:**

- The draft recovery plan is currently under development
- Protect lands with known occurrences of either species of Pseudobahia, particularly those occurrences with the largest and most dense populations, through conservation easements, acquisition in title, or other methods. Manage these properties to protect and enhance growth of P. bahiafolia and P. peirsonii (USFWS, 2007).
- Work with landowners to gain access to their property for surveying and monitoring populations of both Pseudobahia species (USFWS, 2007).
- Conduct coordinated surveys of all recorded occurrences of both species of Pseudobahia. Establish systematic periodic surveys where possible of known occurrences. Begin surveys in potentially suitable habitat of both species of Pseudobahia based on soil type and habitat characteristics (USFWS, 2007).

- Complete and publish the draft recovery plan and ultimately finalize the recovery plan. Much of the information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan (USFWS, 2007).
- Maintain a viable, protected seed collection for both species of Pseudobahia. Ensure sufficient seeds (approximately 5,000 per site, USFWS 2006a) are taken from as many sites as possible to maintain genetic heterogeneity (USFWS, 2007).
- Recovery Priority Number: 5C

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Hartweg's golden sunburst and San Joaquin adobe sunburst. Some of these recommendations have already been discussed in the previous 5- year review (Service 2007, pp. 17–18) and remain valid. 1. Habitat Acquisition, Management, and Restoration. Known occupied sites with Hartweg's golden sunburst and San Joaquin adobe sunburst present should be protected. Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and large unprotected areas currently occupied by the species should be given the highest priority. Large, formerly occupied sites that are unoccupied but have a high restoration potential and the sites with recent occurrences should also be considered. Protected lands must also be adequately managed or restored based on the best available science to enhance the growth of the species. 2. Work with Landowners to Gain Access and Conduct Coordinated Surveys. Gaining access to private lands where no surveying and monitoring has occurred will provide more information on the species. Coordinate surveys in these previously known occurrences and continue surveys in potentially suitable habitat based on soil type and habitat characteristics, similar to the work Vollmar Consulting conducted in 2010. 3. Develop a Recovery Plan. Hartweg's golden sunburst and San Joaquin adobe sunburst were initially included in a "Draft Recovery Plan for Fifteen Plants from the Southern Sierra Foothills, California". This plan was in development in 2007, however, the plan was never finalized. Much information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan. Additionally, the methods of establishing a new population of Hartweg's golden sunburst at Friant Ranch can be incorporated (Live Oak Associates 2015, entire). 4. Maintain a Viable, Protected Seed Collection. For both Hartweg's golden sunburst and San Joaquin adobe sunburst ensure sufficient seeds, approximately 5,000 per site (Cypher 2006, pp. 2–3), are taken from as many sites as possible to maintain genetic heterogeneity. Currently, there are 4,057 seeds of Hartweg's golden sunburst and 37,069 seeds of San Joaquin adobe sunburst stored (California Plant Rescue 2023, unpaginated) (USFWS, 2023).

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# SPECIES ACCOUNT: *Pseudobahia peirsonii* (San Joaquin adobe sunburst)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An annual herb, about 1-6 dm tall, and loosely covered with white, wooly hairs. Flower heads (March or April) have bright yellow rays and are borne singly at the ends of the branches. (NatureServe, 2015)

**Taxonomy**

Pseudobahia peirsonii has had no changes in its scientific name or to its taxonomic classification since it was first described in 1949 by the California botanist Phillip A. Munz. Common names used for P. peirsonii include San Joaquin adobe sunburst, Tulare pseudobahia, and San Jaoquin adobe sunflower (Stebbins 1991). The San Jaoquin adobe sunburst is the preferred common name since it was used in the original listing notice (62 FR 5542)

**Historical Range**

The historical distribution of Pseudobahia peirsonii is not known because when the species was first described in 1949, extensive areas with suitable habitat for this species in the lower San Joaquin Valley were already converted to agriculture. This extensive land conversion precluded establishing a meaningful baseline survey of P. peirsonii (Stebbins 1991). (USFWS, 2007)

**Current Range**

Three major population concentrations of P. peirsonii now include: east of Fresno in Fresno County, west of Lake Success in Tulare County, and northeast of Bakersfield in Kern County (CNDDB 2007). (USFWS, 2007)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Grasslands/woodlands (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (Inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits non-native grasslands and occasionally grassland-blue oak woodland community ecotones in the Central Valley of California. The composition of the prehistoric grassland communities in this area is unknown; the communities have long-since become dominated by exotic grasses. P. peirsonii occurs only on heavy adobe clay soils which retain moisture into the summer dry season (NatureServe, 2015).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

32 (USFWS, 2007)

**Population Narrative:**

The plant is found at 32 extant occurrences distributed in Fresno, Tulare and Kern Counties. Population numbers can fluctuate widely from one year to another. This fluctuation is believed to depend on annual climatic conditions, specifically the amount of seasonal rainfall, and also on competition from non-native plants (Stebbins 1989, 1991; E. Cypher, CDFG, pers. comm. 2007). Because of these annual fluctuations, population trends for these species are difficult to deduce and can not be reliably completed in a few years of surveys (Stebbins 1989). Actual plant numbers are not as useful an index of population health as is the condition of occupied habitat and general population condition (62 FR 5542) (USFWS, 2007). The current species distribution of San Joaquin adobe sunburst is similar to what we described in our final listing rule and 2007 status review, with occurrences found in Fresno, Tulare, and Kern counties (Table 2; Service 1997, p. 5543; Service 2007, p. 3). Since the 2007 status review, an additional ten new occurrences were added to the Diversity Database, although one is a historical occurrence that is possibly extirpated (Diversity Database occurrence 54; Diversity Database 2023). The known occurrences of San Joaquin adobe sunburst are in three major population concentrations east of Fresno in Fresno County, west of Lake Success in Tulare County, and northeast of Bakersfield in Kern County (Diversity Database 2023). Two new occurrences (52 and 51) expand the known range of San Joaquin adobe sunburst approximately 15 miles south (Diversity Database 2023). Typically, all occurrences report fewer than 5,000 plants and more often only a few hundred plants (Diversity Database 2023). However, occurrence 53, located at Tollhouse Ranch owned by The Nature Conservancy, observed approximately 3,000 plants in 2015 and then over 11,090 plants in 2016 (Diversity Database 2023). Abundance of San Joaquin adobe sunburst fluctuates greatly from year to year due to weather conditions such as rainfall. The surveys that have been completed since the previous 5-year review do not significantly alter our understanding of the species' current distribution or abundance and population estimates or trends have not been determined (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Residential development (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of listing, the threat to P. peirsonii was primarily due to the planned 462-acre combined Quail Lakes housing development and recreational lake in Fresno County that would affect the large occurrence (CNDDB occurrence number 31) of 5,000 plants surveyed in 1990. Completion of this project included compensation for environmental impacts which involved off-site wetland construction, transplantation of P. peirsonii and top soil translocation to a protected area within the development site, and preservation of two high density sub-populations of P. peirsonii within the protected site (EIP Associates 1994). During post-construction monitoring of these sub-populations, P. peirsonii at this location were not seen for four years; however, large numbers were observed in a single season during the fifth year of monitoring (Halstead in litt. 2007). In the 2003 season John Stebbins did not observe any plants at this location (J. Stebbins in litt. 2007). Residential development still remains a threat to P. peirsonii at the following locations (two occurrences): 1. A proposed parcel split of a privately owned 65-acre parcel in Fresno County near the city of Clovis, and the proposed residential development of these sub-parcels, is located within the area described to contain Pseudobahia peirsonii occurrence number 36 (Halstead and Associates 2006, CNDDB 2007). Surveys for P. peirsonii were performed on this property in 2004 and 2005 and no plants were found (Halstead in litt. 2007). We lack adequate information on the reproductive ecology and seed bank dynamics of this species to determine whether or not it may reappear at this site in the future. 2. The proposed Round Mountain Estates project would develop a 600-acre parcel at Round Mountain in Fresno County, an area occupied by about 40 acres of Pseudobahia peirsonii. Surveys in 1993 and 1996 revealed the 40 acres support an apparently stable P. peirsonii population and that current land use continues to be moderate cattle grazing (J. Gurule, Live Oak Associates, pers. comm. 2007). Compensation recommended for this project by the consultant is to protect in perpetuity the 40 acres that contain the P. peirsonii occurrence (Hartesveldt Ecological Consulting Services [now Live Oak Associates] 1996) (USFWS, 2007).

**Stressor:** Agricultural conversion (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** When federally listed in 1997, conversion of habitat to agricultural use was considered a significant but secondary threat to Pseudobahia peirsonii. Eight of the original recorded occurrences of P. peirsonii had already been extirpated from their locale due to various agricultural conversions by the time Stebbins (1991) surveyed the sites. We do not believe that agricultural conversion presents a serious threat to P. peirsonii at this time since occurrences are now on either public land or private land used for cattle ranching (E. Cypher pers. comm. 2007). However, P. bahiifolia is still threatened by agricultural development, as it was at the time of listing, because of the pressure to convert ranch lands with occurrences of P. bahiifolia to orchards and vineyards (E. Cypher pers. comm. 2007) (USFWS, 2007).

**Stressor:** Flooding (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat

**Narrative:** Inundation of Pseudobahia peirsonii plants caused by the creation of Lake Success in Tulare County extirpated two of the originally recorded occurrences of P. peirsonii before the species was listed (Stebbins 1989, CNDDB 2007). Three occurrences of P. peirsonii are now found at the Lake Success Recreation Area which is managed by the U.S. Army Corps of Engineers. Two of these occurrences are historically recorded and one occurrence is believed to be a relict of one of the original occurrences that were documented as extirpated when Lake Success was first filled (EDAW 2006a). Flooding at Lake Success continues to be a threat to the three local occurrences of P. peirsonii (E. Cypher in litt. 2007). Excessive rainfall during an exceptionally wet year could raise the level of Lake Success and cause inundation of at least one of the occurrences (E. Cypher in litt. 2007). In addition, two proposals for the improvement of the Lake Success dam could affect at least one other occurrence of P. peirsonii. The U.S. Army Corps of Engineers plans to move the dam 300 feet downstream of its current location and then increase the size of the new spillway (E. Cypher in litt. 2007). Compensation by transplanting was addressed, but is not considered a reliable option for saving the affected populations of P. peirsonii owing to the limited success of previous transplanting efforts (E. Cypher in litt. 2007). As a result of the creation of Lake Success, one population was subjected to the additional threat of adverse recreational activity, since that population was located on the highly impacted shoreline (Stebbins 1989, 62 FR 5542, CNDDB 2007 The Fancher Creek flood control project, completed in the mid-1990s, impacted about 40 percent of the second largest population of Pseudobahia peirsonii (CNDDB occurrence number 30, 62 FR 5542). However, P. peirsonii are still found at the Fancher Creek site and surveys are conducted on a regular basis (P. Bryan in litt. 2007). The possible inundation of at least part of the existing local occurrence during an exceptionally heavy rainfall season remains a threat to this occurrence because no flood control system can protect against all conceivable flood events (Stebbins 1991, Fresno Metropolitan Flood Control District 2007) (USFWS, 2007).

**Stressor:** Protected occurrences (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Two occurrences of Pseudobahia peirsonii are located on public, nonFederal land in Fresno County owned and managed by the Fresno Metropolitan Flood Control District (CNDDB occurrence numbers 16 and 30). Although these occurrences are monitored by surveys and protected by fencing, flooding remains a possible threat to these occurrences. Lake Success was created when the Tule River was dammed by the earthen Success Dam, which was constructed by the U.S. Army Corps of Engineers in 1961. The property around Lake Success, owned and managed by the U.S. Army Corps of Engineers, located just east of Porterville in Tulare County, contains three occurrences of Pseudobahia peirsonii. Two of these occurrences were previously recorded in the CNDDB as occurrence numbers 10 and 19; however, a new occurrence was also discovered and may be the continuation of a population that was covered by the lake when the Success Dam was first built (EDAW 2006a). The sizes of these populations were recorded as 120 individuals for occurrence 10, 30 individuals for occurrence 19, and 45 individuals for the new occurrence (EDAW 2006a). The population numbers from this recent survey appear to indicate these occurrences are somewhat stable when compared with population numbers recorded in previous surveys (1985, 1986, 1988, 2003) (EDAW 2006a; T. Beyerl, EDAW, pers.comm. 2007). These occurrences receive a certain amount of protection because they are on federally operated public land; however, flooding from this dam remains a viable threat to the local occurrences. Lewis Hill Preserve consists of 110 acres of grass-covered hills with rock outcrops

located north of Porterville in Tulare County. This preserve, owned and managed by the Sequoia Riverlands Trust, contains Pseudobahia peirsonii occurrence number 28, as well as the rare wildflower, Fritillaria striata (striped adobe lily) (Sequoia Riverlands Trust 2007). This preserve is not open to the public. Although formal surveys for the listed plant species have not been conducted since 1990, the presence of P. peirsonii was confirmed by preserve personnel during the 2006 flowering season (H. Destin, Sequoia Riverlands Trust, pers. comm. 2007). Currently the Lewis Hill preserve is not actively managed, but future management activities such as prescribed burns and grazing are being planned to control invasive weedy plants (H. Destin pers. comm. 2007). Before Pseudobahia peirsonii was listed in 1997, as compensation for impacts to the four subpopulations of occurrence number 31 by construction of the Quail Lake residential development in Fresno County (see above), two of the highest-density sub-populations were protected and a new sub-population was created by trans-locating soil from the two impacted sub-populations and seeding the soil with seeds collected earlier (completed in 1993) (62 FR 5542, EIP Associates1994). This compensation was done in compliance with the California Endangered Species Act and California Environmental Quality Act. The area, south of Clovis in Fresno County, containing these sub-populations is protected as natural habitat in perpetuity (EIP Associates 1994). Subsequent monitoring revealed that individuals originating from seeds sewn into the trans-located soil, as well as the individual plants in the original two dense populations, were numerous, healthy, and reproducing in 1998 (J. Halstead in litt. 2007). However, P. peirsonii is not clearly present at Quail Lakes every year and the habitat in the area of the translocated soil appeared to be significantly degraded in 2006 (J. Halstead in litt. 2007, J. Stebbins in litt. 2007) (USFWS, 2007).

**Stressor:** Overgrazing and trampling (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of individual plants
**Narrative:** Cattle ranching was recognized as a threat to the Pseudobahia species in the original listing rule (62 FR 5542) because of the possibility of excessive grazing and trampling by cattle, which could destroy many individuals of the two species (Stebbins 1989). In 1997, when first listed, about 50 percent of known occurrences of P. peirsonii were found on private property that was used primarily for cattle grazing. Moderate grazing regimes are not believed to seriously affect either of the plant species, and may actually enhance their growth due to the removal of nonnative, aggressive, invasive grasses and forbs (Stebbins 1989, Marty 2005). Cattle do not preferentially target either of the Pseudobahia species while grazing (E. Cypher pers. comm. 2007). In addition, profitable cattle ranching may indirectly benefit the two Pseudobahia species by discouraging residential development of ranch land (E. Cypher pers. comm. 2007). Cattle grazing and trampling are no longer considered a serious threat to either species unless the grazing times are extended, leading to excessive trampling and consumption (USFWS, 2007).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** When listed in 1997, we noted that most of the occurrences of both the Pseudobahia species were located on private land and, thus, State and Federal laws were limited in their ability to regulate potentially detrimental human activity at these locations (62 FR 5542). No significant changes to the Federal or State laws have provided increased protection for these

species (USFWS, 2007).

**Stressor:** Non-native plants (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The final listing rule noted that the intrusive and aggressive characteristics of herbaceous weedy species appear to be detrimental to habitat quality of the two Pseudobahia species. Plants mentioned as being common non-native associates of P. bahiifolia include Erodium circutarium (red-stem filaree), E. botrys (longbeak stork's bill), Bromus mollis (soft brome or soft chess), and Bromus madritensis ssp rubens (foxtail chess). Plants mentioned as being common non-native associates of P. peirsonii include Avena fatua (wild oats), Brassica kaber (wild mustard), Bromus mollis (soft brome or soft chess), Bromus madritensis ssp rubens (foxtail chess), and Erodium circutarium (red-stem filaree) (62 FR 5542). Non-native grasses and forbs continue to proliferate throughout the range of the two Pseudobahia species and these non-native species continue to invade locations that the two species occupy. Thus, non-native plants remain a significant threat to the two Pseudobahia species (E. Cypher pers. comm. 2007) (USFWS, 2007).

**Stressor:** Road maintenance and widening (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Stebbins (1991) lists several road maintenance projects that would affect populations of Pseudobahia peirsonii. The most extensive project was the proposed widening of State Route 180 in Fresno County that may destroy plants on both sides of the road. Six other occurrences were also determined to be threatened by road maintenance activities conducted by the California Department of Transportation (CALTRANS) which include spraying herbicides, grading, scraping, slope stabilization, road widening, and road alignment. The listing rule noted that road maintenance activities were a threat to P. peirsonii (62 FR 5542). However, subsequent CALTRANS maintenance activities and road alignment did not appear to directly affect the occurrences of P. peirsonii; rather, the disturbance created from the maintenance appears to indirectly and moderately threaten both species of Pseudobahia by encouraging the growth of non-native weedy vegetation which competes with the two listed species of Pseudobahia (J. Stebbins in litt. 2007) (USFWS, 2007).

**Stressor:** Transmission line maintenance (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Two occurrences of Pseudobahia peirsonii (CNDDB occurrence numbers 23 and 24) inhabit areas beneath two transmission lines supported by Southern California Edison (SCE). The properties where the transmission lines are located are considered "rights of way", and are mostly within privately owned lands. Stebbins (1991) recognized that these populations would need to be protected from the machinery and traffic (human and vehicular) that would impact the area when maintenance actions were performed on the transmission lines, and this was considered a threat when the species was listed (62 FR 5542). Routine maintenance activities include patrol road maintenance, line maintenance, and overhead canopy maintenance. Routine

maintenance actions are scheduled by SCE annually, avoid the active time periods for local listed plants, and require a minimum of off-road activities (Entrix, Inc. 1997). A more substantial threat to P. peirsonii is from emergency repairs to the power lines due to catastrophic failure, natural disasters, or vandalism where the need to conduct repairs expeditiously would increase the chances of incidental damage to the plants during the repair effort. Entrix, Inc. (1997) conducted a survey for P. peirsonii and found only one occurrence along one of the two transmission lines where the species was thought to occur. SCE maintenance personnel are provided with environmental and endangered species training to ensure they avoid impacting listed species (Entrix, Inc. 1997) (USFWS, 2007).

**Stressor:** Drought (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of listing drought was considered a threat to small and marginal populations of either Pseudobahia species (62 FR 5542). Natural cycles of drought are not likely to threaten the larger occurrences of either of the Pseudobahia species owing to the drought-adaptive nature of the plants (E. Cypher pers. comm. 2007). However, where populations persist on only marginal habitat, the addition of prolonged drought conditions is likely to result in higher rates of mortality in the short term, with the effects of low reproductive output and survivorship persisting after the drought has ceased (E. Cypher pers. comm. 2007). It is unknown how quickly the Psuedobahia populations may rebound after severe climatic conditions (USFWS, 2007).

**Stressor:** Small population size (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:** Loss of genetic variability
**Narrative:** The two species of Pseudobahia each require separate and specific soil conditions for successful germination and growth, so that the distribution of these plants is limited to the occurrences of these soil types (Stebbins 1991). The conversion to agricultural use of the geographic areas where these soil types are found began before a baseline survey of either plant could be performed, so the historic distribution can only be assumed based on a variety of factors, including soil type. The conversion to agriculture and to other land uses (discussed above) which are adverse to the proliferation of the two species have resulted in fragmented populations, many of which are of extremely limited population size (E. Cypher pers. comm. 2007). For example, about 67 percent of the P. bahiifolia and 62 percent of the P. peirsonii populations with known counts have less than 100 plants from the last surveys that were recorded (CNDDB 2007). In addition, some of the sites are questionable as to whether they are still producing any plants at all; for example, two of the presumed extant occurrences of P. bahiifolia are single sightings of unknown numbers of plants that have not been verified since 1937 and 1939, respectively (CNDDB 2007). At the time of listing it was recognized that such small populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987, 62 FR 5542). The conservation biology literature commonly notes the vulnerability of species known from one or very few locations and/or from small populations (e.g., Shaffer 1981 and 1987, Primack 1998, Dunning et al. 2006). In particular, small population size makes it difficult for such species to persist while sustaining the impacts of habitat loss, competition with non-native plants, and other impacts such as prolonged drought. If an extirpation event occurs in a

population that has been fragmented, the opportunities for re-colonization will be greatly reduced due to physical isolation from other source populations. The small size of populations, along with the geographic isolation of the separate populations of both Pseudobahia species remains a threat (E. Cypher pers. comm. 2007) (USFWS, 2007).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2

**Recovery Actions:**
- The draft recovery plan is currently under development (USFWS, 2007).
- Protect lands with known occurrences of either species of Pseudobahia, particularly those occurrences with the largest and most dense populations, through conservation easements, acquisition in title, or other methods. Manage these properties to protect and enhance growth of P. bahiafolia and P. peirsonii (USFWS, 2007).
- Work with landowners to gain access to their property for surveying and monitoring populations of both Pseudobahia species (USFWS, 2007).
- Conduct coordinated surveys of all recorded occurrences of both species of Pseudobahia. Establish systematic periodic surveys where possible of known occurrences. Begin surveys in potentially suitable habitat of both species of Pseudobahia based on soil type and habitat characteristics (USFWS, 2007).
- Complete and publish the draft recovery plan and ultimately finalize the recovery plan. Much of the information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan (USFWS, 2007).
- Maintain a viable, protected seed collection for both species of Pseudobahia. Ensure sufficient seeds (approximately 5,000 per site, USFWS 2006a) are taken from as many sites as possible to maintain genetic heterogeneity (USFWS, 2007).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Hartweg's golden sunburst and San Joaquin adobe sunburst. Some of these recommendations have already been discussed in the previous 5- year review (Service 2007, pp. 17–18) and remain valid. 1. Habitat Acquisition, Management, and Restoration. Known occupied sites with Hartweg's golden sunburst and San Joaquin adobe sunburst present should be protected. Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and large unprotected areas currently occupied by the species should be given the highest priority. Large, formerly occupied sites that are unoccupied but have a high restoration potential and the sites with recent occurrences should also be considered. Protected lands must also be adequately managed or restored based on the best available science to enhance the growth of the species. 2. Work with Landowners to Gain Access and Conduct Coordinated Surveys. Gaining access to private lands where no surveying and monitoring has occurred will provide more information on the species. Coordinate surveys in these previously known occurrences and continue surveys in potentially suitable habitat based on soil type and habitat characteristics, similar to the work Vollmar Consulting conducted in 2010. 3. Develop a Recovery Plan. Hartweg's golden sunburst and San Joaquin adobe sunburst were initially included in a "Draft Recovery Plan for Fifteen Plants from

the Southern Sierra Foothills, California". This plan was in development in 2007, however, the plan was never finalized. Much information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan. Additionally, the methods of establishing a new population of Hartweg's golden sunburst at Friant Ranch can be incorporated (Live Oak Associates 2015, entire). 4. Maintain a Viable, Protected Seed Collection. For both Hartweg's golden sunburst and San Joaquin adobe sunburst ensure sufficient seeds, approximately 5,000 per site (Cypher 2006, pp. 2–3), are taken from as many sites as possible to maintain genetic heterogeneity. Currently, there are 4,057 seeds of Hartweg's golden sunburst and 37,069 seeds of San Joaquin adobe sunburst stored (California Plant Rescue 2023, unpaginated) (USFWS, 2023).

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# SPECIES ACCOUNT: *Ptilimnium nodosum* (Harperella)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/28/1988; Northeast Region (Region 5) (USFWS, 2015)

**Physical Description**

An annual herb with slender, erect stems, up to 12 dm high. The roots are shallow, diffuse-fibrous, and the plants have a faint scent of dill. Unlike those of the more common members of this genus, the leaves of P. nodosum are reduced to hollow, quill-like structures. Broad clusters of small white flowers bloom mostly in July and August. (NatureServe, 2015)

**Taxonomy**

As of 2008, the U.S. FWS treatment includes P. fluviatile (AR, AL; river form, does not produce asexual buds), P. viviparum (MD, WV, VA, NC; river form, produces asexual buds), and P. nodosum sensu stricto (GA, SC; pond form) in P. nodosum, as does Kartesz (1994 and 1999); this is the treatment followed here. However, recent information suggests they may be tentatively treated as distinct entities, although not necessarily as distinct species (David Maddox pers. comm. to Alan Weakley and to Larry Morse). Specifically, a 1994 isozyme study found that there was substantial genetic differentiation among rather than within these three groups, supporting designation as distinct entities (Kress et al. 1994 cited in Douglas 2008). A 2008 DNA study (nuclear rDNA ITS sequences) found that "viviparum" accessions formed a monophyletic group, but "nodosum sensu stricto" accessions did not, with South Carolina populations forming a monophyletic group, but Georgia populations falling at the base of the clade alongside "fluviatile" accessions (Feist and Downie 2008). In summary, although there is clearly more than one distinct entity within the current broad-sense circumscription of P. nodosum, there is not yet a clear consensus on how to divide the material and at what taxonomic level entities should be distinguished. (NatureServe, 2015)

**Current Range**

Currently known from scattered sites in western Maryland, eastern West Virginia, northeastern Virginia, north-central North Carolina, central South Carolina, central Georgia, northeastern Alabama, and west-central Arkansas. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (vegetatively) and sexual (NatureServe, 2015)

**Lifespan**

Adult: 1 year (USFWS, 2015)

**Breeding Season**

Adult: July to August (USFWS, 1990)

**Reproduction Narrative**

Adult: Ptilimnium nodosum is an annual that reproduces both vegetatively and via seed; it is thought that established patches may persist over the long-term primarily by vegetative reproduction, while novel habitat colonization may occur primarily via seed. These multiple reproduction modes also appear to provide a survival mechanism for variable water levels; since sexual reproduction becomes more difficult within increasing water depth, the plants produce seeds and reproduce sexually in dry years, while in wet years they produce plantlets and reproduce vegetatively. It appears that both forms of reproduction contribute to overall population size in most years, with the contribution of each dependent upon hydrological patterns (Douglas 2008). Marcinko and Randall (2008) studied the mating system of P. nodosum, with the following findings. Flowers were self-compatible, but strong intrafloral protandry essentially prevented autonomous selfing. (NatureServe, 2015)

**Habitat Type**

Adult: Riverine, and palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Spring/spring brook, herbaceous wetland, riparian, temporary pool (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Saturated sites; flooding; water fluctuations (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Prefers saturated habitat, periodic flooding, sunny areas. Restricted to intermediate water depths (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Patches (USFWS, 1990)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (USFWS, 1990)

**Site Fidelity**

Adult: High (USFWS, 1990)

**Habitat Narrative**

Adult: Ptilimnium nodosum occurs in three habitat types: rocky/gravelly shoals or cracks in bedrock outcrops beneath the water surface in clear, swift-flowing streams (usually in microsites that are sheltered from rapidly moving water); edges of intermittent pineland ponds or low, wet savannah meadows on the Coastal Plain; and granite outcrop seeps. In all habitat-types, the species occurs in a narrow range of water depths; it is intolerant of deep water and of conditions that are too dry. However, the plants readily tolerate periodic, moderate flooding - something to which few potential competitors are adapted. P. nodosum seeds generally germinate during short-duration spring floods and the plants have completed their life cycle by late summer or fall, just as water levels are lowest and competing species are moving in. The dominant species at P. nodosum sites is often Panicum hemitimon. Other species may include many sedges in the genera Rhynchospora (e.g., B. perplexa, R. microcarpa), Carex (e.g., C. walteri, C. lupulina), Eleocharis (e.g., E. tricostata, E. melanocarpa), Psilocarva, Dichromena colorata, and Fimbristylis. Dicot associates include Hypericum fasciculatum, ii. denticulatum, H. myrtifolium, Rhexia vircrmnica, R. mariana, B. aristosa, Proserpinaca pectinata, several Ludwicria species, and Sclerolepis uniflora (Kral 1983). (USFWS, 1990; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal**

Adult: Low (USFWS, 1990)

**Dispersal/Migration Narrative**

Adult: Seeds readily float, so dispersal probably is mediated by water flow; however, safe sites downstream are infrequently and haphazardly found. Further, seeds have no structures to facilitate aerial dispersal and drop quickly to the ground, with many seeds germinating directly under the parent plant. The natural founding of new pond populations is probably very rare because of the plant’s (apparently) poor capacity for long distance dispersal and the fragmented dispersion of appropriate habitat. Thus, seed dispersal to new sites is probably a rare event. (USFWS, 1990)

***Population Information and Trends***

**Population Trends:**

Long-term trends suggest a decline of 30 to 70%, whereas short-term trends indicate a decline of >50% (NatureServe, 2015)

**Species Trends:**

Declining (NatureServe, 2015)

**Number of Populations:**

28 (USFWS, 2024)

**Population Size:**

>1,000,000 (USFWS, 2024)

**Additional Population-level Information:**

28 Total extant populations, 16 of which are protected (USFWS, 2024)

**Population Narrative:**

This species may be somewhat resistant, but is sensitive to dry conditions and dependent on narrowly defined hydrologic conditions. Vulnerable to upstream development. Many sites have been lost. Approximately 25% of mapped occurrences are ranked historical or extirpated. Long-term population trends suggest a decline of 30 to 70%, whereas short-term trends indicate a decline of greater than 50%. The total number of known individuals appears to be approximately 500,000. One population (drainage/watershed) in West Virginia is estimated to contain 400,000 plants, and all populations in Arkansas are estimated to total 50,000-100,000 plants in a good year (Douglas 2008). Many of the other extant populations are small; nine of the populations (drainages/watersheds) are estimated to contain less than 400 plants (Douglas 2008). Approximately 45 occurrences are believed extant, about half of which are in Arkansas with the other states in the range having 1-5 each. Thirteen occurrences are considered historical (predominantly in Alabama and South Carolina) and 1 (in Georgia) has been extirpated. The U.S. Fish and Wildlife Service (Douglas 2008) regards 24 "populations" as extant, with "population" defined as "sites located within one drainage or watershed... each may have a number of discrete sites (element occurrences)." Under this view, there are 9 extant populations in Arkansas and 1-3 in each of the other states. (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Water fluctuations (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fluviatile tends to occupy a narrow range of water depths, manipulations of water flow upstream from populations can easily destroy suitable habitat by inundation or persistent desiccation. Dams, reservoirs, or other water impoundments or diversions would almost certainly threaten any P. nodosum downstream. Natural fluctuation in water flow causes significant yearly variation in subpopulation persistence. Small subpopulations are particularly susceptible to loss during normal high water events. Thus, small populations such as those in North Carolina or Maryland’s Fifteen Mile Creek are at significant yearly risk. Hydrological manipulations on rivers with small populations should be strictly avoided or controlled. Nodosum, like Fluviatile, depends on intermediate water levels and is threatened by either dry conditions or total inundation. Thus, the primary threats to Nodosum populations are hydrological manipulation and physical destruction of their pond habitats. (USFWS, 1990)

**Stressor:** Water quality (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fluviatile is apparently also sensitive to reductions in water quality. Siltation caused by heavy construction, residential development, and agriculture has been cited as detrimental to the plant. The negative effect of sediment on Fluviatile was substantiated in a greenhouse experiment: turbidity equal to that near a bridge construction site reduced Fluviatile growth rate by 40% (Maddox and Bartgis 1990b). (USFWS, 1990)

**Stressor:** Stream acidification (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Another greenhouse experiment indicates that stream acidification (especially pH ~ 5.0) may cause significant plant mortality (Maddox and Bartgis 1990b). Plants growing in water with pH approximately equal to 3.4 had a 70% mortality rate; in water with pH = 4.6 plants grew at a significantly lower rate than controls. This is potentially important in Alabama, where the extant population has historically experienced low pH due to mining. At Maryland and West

Virginia sites, the pH is typically 7.0. However, the acid neutralizing capacity is very low, suggesting that minor acid inputs could significantly lower pH. Other water quality variables, such as increased sewage or nitrate concentration, may also be detrimental. (USFWS, 1990)

**Stressor:** Alterations in hydrology (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Coastal plain ponds everywhere are threatened by active drainage for conversion to pine plantations or row crops (Godfrey and Wooten 1979). Lowered water tables are probably detrimental to Nodosum through increased competitive and physiological stress. While hydrological manipulations directly to the pond are clearly detrimental, ditching and other manipulations of the water table from some distance away may affect coastal plain ponds, although the exact area of effect is not known (Pat Phillips, U.S. Geological Survey, pers. comm. 1989). The effective distance of such manipulations clearly is important in determining the zone around a population needed to ensure protection of the hydrological resource. (USFWS, 1990)

**Stressor:** Dredging (USFWS, 1990)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Occasionally ponds are dredged to create deep ponds for livestock; these deeper water levels probably disrupt the life cycle of Nodosum, a small plant. (USFWS, 1990)

***Recovery***

**Reclassification Criteria:**
1. Thirteen populations (the number of currently extant populations) have been relatively stable in population size for five years. (USFWS, 1990)

2. All thirteen populations are permanently protected. (USFWS, 1990)

Recovery Priority Number: 8

**Delisting Criteria:**
1. Thirteen populations (the number of currently extant populations) have been relatively stable in population size for five years. (USFWS, 1990)

2. All thirteen populations are permanently protected. (USFWS, 1990)

3. There are at least 26 self-sustaining populations in existence. To reach this level, at least thirteen new populations will have to be discovered or established. This is the total number of current and historically known populations. (USFWS, 1990)

4. The populations are distributed throughout the historical range from Arkansas to Maryland. (USFWS, 1990)

5. All 26 populations are permanently protected. (USFWS, 1990)

**Recovery Actions:**

- Protect plants and their habitat through landowner cooperation, land protection, and regulatory authorities. (USFWS, 1990)
- Where needed, seek conservation of watersheds to protect populations. (USFWS, 1990)
- Search for additional populations. (USFWS, 1990)
- Study species and habitat characteristics. (USFWS, 1990)
- Develop a cultivated sources of plants and provide for seed storage. (USFWS, 1990)
- Implement appropriate management techniques, particularly for pond populations. (USFWS, 1990)
- Re-establish populations within the species' historical range. (USFWS, 1990)
- Inform the public about the plant's status and recovery needs. (USFWS, 1990)
- Population surveys and inventories have been performed at all current sites by State Heritage Programs or botanists from various universities. Active population monitoring occurs only in Maryland and West Virginia. (USFWS, 1990)
- Surveys for new populations have been undertaken in all states containing extant populations, except Arkansas. New populations were verified in Maryland in 1988 and Arkansas in 1990. Significant potential habitat or recent unconfirmed records remain to be investigated in Alabama, Georgia, North and South Carolina, Arkansas, southern Missouri, and eastern Oklahoma. (USFWS, 1990)
- The Nature Conservancy, Western Pennsylvania Conservancy, and Maryland Department of Natural Resources have begun a comprehensive program to protect Sideling Hill Creek, including upstream areas as buffer. To date, a number of tracts have been registered in Maryland and Pennsylvania, a tract has been acquired on the border of Maryland and Pennsylvania, and the potential purchase of the most significant tract supporting p. nodosum is being negotiated by the State of Maryland and The Nature Conservancy. (USFWS, 1990)
- The Nature Conservancy has acquired an easement on one Cacapon River subpopulation. Additional subpopulations in West Virginia have been added to the Conservancy's registry program. The U.S. Fish and Wildlife Service contracted with The Nature Conservancy in 1990 to expand landowner contact efforts on the Cacapon River. (USFWS, 1990)
- The Maryland Natural Heritage Program has conducted an extensive two—year investigation of the ecology and life history of Fluviatile (Maddox and Bartgis 1989, 1990a, 1990b). (USFWS, 1990)
- The Maryland Natural Heritage Program has collaborated with the Smithsonian Institution on a study of electrophoretically detectable genetic variation throughout the range of P. nodosum. This study is expected to be completed in spring of 1991. (USFWS, 1990)
- The Maryland Natural Heritage Program has produced and distributed several information brochures on the biology of P. nodosum and its habitat. (USFWS, 1990)
- In a 1988 survey conducted by the Center for Plant Conservation to determine the plant taxa in most imminent danger of extinction, P. nodosum was identified by botanists as a "B" priority taxon, i.e., one which could go extinct in the wild within the next ten years. The Center has assisted in the recovery of the plant: 7,500 seeds have been collected as part of the National Collection of Endangered Plants and are housed at the North Carolina Botanical Garden (NCBG), one of the Center's participating institutions in the region. All seeds were collected from the Tar River area in Granville County, North Carolina. Although not currently being propagated at NCBG, these seeds provide a valuable conservation resource. (USFWS,

1990)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The following is a list of priority future actions based on this review. If the proposed action was also identified in the recovery plan, the action number from the plan is listed. Monitoring & Population Viability Research (Recovery Plan Actions 5.1 & 5.2): More consistent monitoring both for individual populations and between populations is needed throughout the species' range. Monitoring of some populations has not occurred or has been infrequent, and it is difficult to assess the overall status of the species as a result. The proposed monitoring protocol from the recovery plan should be reviewed and updated, and then used consistently throughout the range of the species so that data between populations are more comparable. Monitoring should record changes to the watershed from effects such as: changes in or modifications to the hydrologic regime, siltation, pollutants, and invasive competitors. Additional monitoring and research to help understand the significance and extent of population fluctuations is also required to help biologists and managers determine what the minimum viable population size is and/or when a population can be considered self-sustaining. Establishing these types of measures will allow managers to more effectively evaluate population trends in relation to the recovery status of the species. More consistent monitoring of individual populations would allow threats to be identified and potentially averted and would provide more comprehensive information on the rangewide population status. Revisions to the monitoring protocols may be necessary over time to take into account the results of any population viability research that may be conducted and/or assist in gathering data that would support the needed research. Seed collection, storage, and cultivation (Recovery Plan Action 7.0): To preserve germ plasm and genetic diversity of the species, efforts to gather and store seeds from throughout the range should be increased. The North Carolina Botanical Garden has established a program to provide for long-term seed storage, and some efforts in this regard have been made. Some seeds have also been stored at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. However, a more coordinated and concentrated effort is needed. This is particularly important for populations that may be extremely small, threatened, or isolated such as those in Virginia and pond-form populations in South Carolina and Georgia. Samples from the southern and western portion of the range (Alabama and Arkansas) are also lacking. Efforts to cultivate plants from various populations to maintain a source of plants for reintroduction projects should also be increased. The importance of this is illustrated by the fact that the potentially unique genotype from the Siloam Outcrop site in Georgia could have been permanently lost if not for the fortuitous collection and cultivation of plant material prior to the unexpected destruction of the site. A coordinated database of the source and location of stored seeds and cultivated materials is also needed, so that biologists and researchers can access this material and minimize additional disturbances to natural populations. Conduct further genetic and morphological studies (Recovery Plan Action 6.0): Additional research to evaluate genetic diversity in populations throughout the range is needed to help inform management efforts, including potential propagation, augmentation, and reintroduction efforts. Common garden tests should also be conducted that would take individuals from various locations encompassing the range of morphological characteristics expressed by the species and then grow them under uniform conditions in the greenhouse. This would provide an economical way to allow researchers to determine whether the variations in form are genetically or environmentally induced. Results from these studies would help guide management decisions such as selecting source populations for reintroduction/augmentation efforts and prioritizing populations for protection. They would also help further clarify whether recovery units should be established, or recovery criteria should be revised to ensure that genetic and morphological diversity is maintained. Long-term protection and management (Recovery Plan Actions 1.5 & 2.0): A combination of both protection of occupied habitats and development of watershed-level management plans is needed to accomplish this task. Focused management strategies should be developed for distinct portions of the range. For example, long-term protection is particularly important for pond-form populations. Only five are known to exist. Three of these populations are tenuous, another one is a reintroduction site, and only one of the five is permanently protected. Efforts should be increased to place the remaining pond form populations under protection, through either direct purchase or conservation easement. Because the habitats that support the pond form tend to be more discrete than riverine systems, it is much easier to permanently protect these populations and manage threats. For riverine populations, efforts should be increased to purchase or manage additional lands in watersheds that already have some protection, thereby reducing the potential for threats. For larger-scale watersheds, or those that are primarily private lands, managers should also focus on working with watershed groups, local governments, or other entities to develop management guidelines, zoning criteria, improved water quality standards, and other similar measures (USFWS, 2024).

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# SPECIES ACCOUNT: *Purshia (=Cowania) subintegra* (Arizona Cliff-rose)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/29/1984; Southwest Region

**Physical Description**

Arizona cliffrose is a member of the Rose Family (Rosaceae). It is a low, straggling woody perennial usually 1 - 2 meters (in) (3 - 6 feet) high and generally wider than tall. In the Cottonwood population, plants can reach a maximum of 2.4 in (8 feet) tall and 3.7 m (12 feet) in diameter. The horizontal lower branches are spreading, and the central branches are irregularly ascending (Denhain and Fobes 1992b). New shoots tend to be red-brown and pubescent with a red dot below the fascicle. The older branches have light gray bark that becomes shreddy. The herbage is not viscid (sticky), although some resin glands may be present, causing slight stickiness. The shape of Purshia subintegra leaves is variable. The leaves are very narrow and short: averaging about 8 millimeters (mm) (0.3 inch) long (Denham and Fobes 1992b) and 3 mm (0.1 inch) wide. Leaves usually have no lobes, but occasionally have 1 or 2 rounded, shallow lobes or teeth just below the leaf tip. The margins (edges) of the leaves are curled towards the underside (revolute). The upper leaf surface is bright or dark green and usually has no punctate glands. The upper leaf surface is usually loosely arachnoidpubescent (having a few long hairs) on the upper surface, but sometimes it is hairless. The lower surface is densely white-lanate (wooly) and usually has no punctate glands. Each flower is born on a single stalk (peduncle). The end of the peduncle gradually merges with the beginning of the narrowly funnelform hypanthium, the flower part bearing the sepals, petals, and stamens. The average length of the hypanthium plus peduncle is 5.1 mm (< 0.3 inch) (Reichenbacher 1993). The hypanthium has no stipitate (stalked) glands or has few glands. The typical flower has 3 - 7 pistils and 5 white or pale yellow petals that are about 10 mm (0.4 inch) long, slightly smaller than P. stansburiana flowers. Occasionally, flowers have 8 - 12 petals per flower (Denham and Fobes 1992a). As the achenes (fruits) develop, the style remains attached and forms a short, white, feathery plume. (USFWS, 1995)

**Taxonomy**

Purshia subintegra genetic variability, phenotypic plasticity, and past and recent hybridization with P. stansburiana have complicated taxonomic identification. Phenotypic and genetic variability among populations has been studied using morphometrics and molecular (DNA) analysis. Schaack (1987) described the San Carlos Basin (i.e., Bylas) population of P. subintegra as P. pinkavae, and designated P. subintegra to be of hybrid origin involving a cross between P. stansburiana and P. pinkavae. Kartesz (1994) treats P. subintegra as a hybrid. Reichenbacher (1994) states that although there is some character variation between the four populations of P. subintegra, multivariate analysis clearly indicates they exhibit a coherent syndrome of characters, and the taxonomy developed by Schaack is not supported by the analysis. The Recovery Plan concludes that P. subintegra is distinct from the more common P. stansburiana, despite sometimes overlapping plant characteristics (USFWS 1995). Travis et al. (2008) re-examined the genetic variation within P. subintegra and state that molecular evidence indicates a distinct classification for the Bylas population in support of the hypothesis that this population represents a separate species per Schaack (1987). However, the authors conclude that a broader taxonomic analysis of the genus is necessary to confirm such a distinction. Henrickson's unpublished description of P. subintegra notes considerable variation in key characteristics within the species. Characteristics used for identification, such as occasionally lobed (or toothed) leaves, exhibit a continuum of variability between and within individuals, change seasonally (e.g., as leaves are shed during drier periods sometimes leaving only unlobed leaves), and sort out independently from other key characteristics. The demarcation between Schaack's pinkavae and P. subintegra is not discrete (Henrickson, pers. comm., 2013). Pending further studies, the USFWS continues to recognize that the four described populations of P. subintegra comprise one distinct species. Regarding nomenclature, Travis et al. (2008) present strong evidence for a hybrid origin of P. subintegra. Based on their molecular data and hypothesized pre-historic biogeography of the region (Anderson 1993), hybridization occurred during the late Pleistocene (11,000 to 13, 000 years before the present). There has been a growing consensus for this explanation and increased use of the following nomenclature indicating a hybrid origin: Purshia ×subintegra (Kartesz 2013; Integrated Taxonomic Information System, 2013). However, such a designation for a species believed to be of hybrid origin is discretionary (International Code of Botanical Nomenclature (Article H:3.3) 2012). (USFWS, 1995))

**Historical Range**

See Current Range.

**Current Range**

In Arizona, in Graham, Maricopa, Mohave, and Yavapai counties. All known occurrences of P. subintegra are located in four disjunct populations, which occur along the sub-Mogollon region of central Arizona over a distance of 320 kilometers (200 miles) (Rutman 1992). (USFWS, 2013)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food Source**

Adult: sunlgiht

**Competition**

Adult: yes, especially creasote

**Food/Nutrient Narrative**

Adult: This species aquires its energy from sunlight via photosynthesis.

**Reproductive Strategy**

Adult: Flowering plant that attracts pollinators

**Lifespan**

Adult: many years

**Dependency on Other Individuals or Species**

Adult: lepidopterans, dipterans, and bees

**Breeding Season**

Adult: late March through early May

**Reproduction Narrative**

Adult: Purshia subintegra generally flowers from late March through early May and is visited by a wide variety of insects, including lepidopterans, dipterans, and bees. Typically, hundreds of flowers are produced on each mature plant, which can reproduce for many years (USFWS 1995). Flower and seed production varies between years based on climatic conditions, plant vigor, browsing, and other factors. Native wild bees and introduced honeybees (Apis mellifera) are the most important pollinators, the latter becoming the predominant pollinator later in the flowering season (Fitts et al. 1993). Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995). Experiments have shown that this species is partially self-compatible, but sets significantly more seeds and produces fruit more often when outcrossed (Fitts et al. 1993).

**Habitat Type**

Adult: desert

**Habitat Vegetation or Surface Water Classification**

Adult: limestone soils

**Geographic or Habitat Restraints or Barriers**

Adult: Restricted by competition with other plants

**Spatial Arrangements of the Population**

Adult: Clumped according to suitable resources

**Environmental Specificity**

Adult: specialist; narrow habitat requirements

**Tolerance Ranges/Thresholds**

Adult: unknown

**Site Fidelity**

Adult: high

**Habitat Narrative**

Adult: This species has narrow habitat requirements and occurs at four widely separated areas across central Arizona. These sites differ slightly in elevation and associated vegetation, but all sites have limestone soils (generally white but also reddish in color) derived from Tertiary lacustrine (lakebed) deposits. At each site P. subintegra is part of a locally unique vegetative community (Anderson 1993). The geographic and local distribution of P. subintegra appears to be limited by competition from other plant species rather than a requirement for a specific soil type. These soils are relatively infertile and have significantly lower amounts of phosphorus and organic matter compared with surrounding areas where P. subintegra is absent (Anderson 1986, 1993). These surrounding areas are typically dominated by creosotebush (Larrea tridentata), which is thought to have a competitive advantage over P. subintegra due to its aggressive seedling establishment (Anderson 1993). Creosotebush is unable to grow on the relatively infertile lacustrine soils. However, it has been found growing together with P. subintegra in the Verde Valley, in areas with higher amounts or organic matter and phosphorus. This suggests that the distribution of P. subintegra within these limestone soil conditions is limited primarily by competition from creosotebush, rather than a requirement for specific soil properties (Anderson 1986, 1993, 1996).

***Dispersal/Migration***

**Motility/Mobility**

Adult: not mobile

**Dispersal**

Adult: only the seeds

**Dispersal/Migration Narrative**

Adult: Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995).

***Population Information and Trends***

**Population Trends:**

Declining

**Species Trends:**

Declining

**Population Growth Rate:**

unknown

**Number of Populations:**

4 (USFWS, 2022)

**Population Size:**

Unknown, estimated to exceed 40,000

**Minimum Viable Population Size:**

unknown

**Resistance to Disease:**

unknown

**Population Narrative:**

The total number of plants in the four P. subintegra populations is not known, but has been estimated. Not all areas of potential habitat have been surveyed, and in some areas, such as Cottonwood, the presence of hybrids between P. subintegra and P. stansburiana, or introgressed forms, has complicated population estimates (USFWS 2001). Despite the potential conservation significance of hybrids, the USFWS considers these plants to be outside the definition of the species (USFWS 1995) and are not included in population estimates. In 1988, a total number for all four populations (i.e., recovery units) was estimated to exceed 40,000 plants, although a large percentage may have included hybrids (USFWS 1988). About 10,000 plants are thought to currently occur in the predominant subpopulation at Burro Creek (USFWS 2004). At the time of listing, the USFWS estimated 243 ha (600 ac) of habitat at Burro Creek, and 40 ha (100 ac) at Bylas with an estimated 700 plants (USDI 1984). The Horseshoe Lake population is estimated to include 750 plants (USFWS 1987) over an unspecified area. The Cottonwood population covers the largest area, estimated at over 405 ha (1,000 ac) (USFWS 1995), with the amount of occupied habitat recently calculated to be 78 ha (194 ac) (Goodwin 2012). Total Cottonwood population numbers were previously not known, but were conservatively estimated to include tens of thousands of plants (USFWS 2007). The most recent, intensive survey places this number considerably lower, at a total of 8,272 P. subintegra plants within the Cottonwood population (Goodwin 2012). Acceptance of this figure would result in a downward adjustment of the estimated total numbers of known plants in the four populations by one-half, or to about 20,000. This adjustment may be the result of a more intensive survey as opposed to a large scale decline in numbers. We have no demographic trend information from monitoring the four populations, but population viability modeling suggests that P. subintegra will slowly decline in the Cottonwood population under more arid scenarios (Maschinski et al. 2006). Purshia subintegra populations are genetically variable, exhibit phenotypic plasticity in response to environmental conditions, and hybridize with P. stansburiana. Gene exchange through backcrossing hybrids (introgression) of P. subintegra and the more common P. stansburiana has resulted in hybrid swarms in the Cottonwood and Horseshoe Lake populations (USFWS 1995). A hybrid swarm is a “hybrid population,” maintained by backcrossing and/or crossing with other hybrids, which may be stable or spread. The proliferation of hybrids has the potential to negatively affect long-term population dynamics of P. subintegra through interference competition and loss of genetic integrity (Fitts et al. 1993; Baggs and Maschinski 2001b). At the same time, hybridization may act as a mechanism to increase genetic diversity in a population, enhancing adaptation and survival, therefore potentially benefiting conservation of P. subintegra (Baggs and Maschinski, 2001b). Hybrid swarms illustrate the migratory and dynamic nature of evolving plant populations, and may provide the key to the future of the genus and species. For this reason, conservation of these hybrid swarms is important (USFWS 1995). A recent study by Travis et al. (2008) confirmed the presence of a hybrid swarm in the Verde Valley and emphasized its conservation significance. Because introgressed forms appear to possess potential fitness advantages under hotter, drier conditions, they may provide a viable refuge for P. subintegra genome in the face of climate change (Travis et al. 2008). The paper also identified three distinct genetic lineages of P. subintegra: the Cottonwood (Verde Valley) population, which is currently undergoing introgression; the Burro Creek and Horseshoe Lake populations, which exhibit an ancient natural hybrid origin; and the Bylas population, which is genetically distinct from the others. These findings underscore the complex genetics of this species and the importance of conserving all four populations. (USFWS, 2013). For Arizona cliffrose, the four recovery units are analogous to the four known populations of the species, which we will refer to as populations from this point forward. The four populations are Burro Creek, Cottonwood, Horseshoe Lake, and Bylas (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Urbanization (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Habitat loss due to urbanization is a serious threat for the Cottonwood Arizona cliffrose population. Urbanization does not appear to be a threat to the other three populations, which are either on Federal land, which precludes urbanization, or they occur where development is unlikely. A significant amount of Arizona cliffrose habitat has already been lost due to development in the Cottonwood area, but the amount of habitat loss has not been estimated. The threat of urbanization continues, because some occupied habitat remains on private lands that could be developed and a substantial amount of habitat is on State Trust land. The transfers of land from Federal ownership into private or State ownership is an indirect threat to Arizona cliffrose. These land exchanges significantly reduce the protections offered by the Endangered Species Act and may contribute to urbanization or other actions causing habitat loss or degradation. These types of transfers would be subject to section 7 consultation procedures. (USFWS, 1995)

**Stressor:** Mineral Exploration and Development (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Mining and mining-related activities are a serious threat to the long-term survival of this species, particularly in the Burro Creek area. The soils supporting Arizona cliffrose populations are known to contain high quality bentonite (BLM 1993), a type of clay used for cosmetics and pharmaceuticals. Drilling and bulk sample procurement have reduced the number of plants and amount of available or undisturbed habitat in the Burro Creek area. (USFWS, 1995)

**Stressor:** Cattle and Feral Burro Browsing Effects (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In 1987, the BLM- Kingman Resource Area began monitoring the effects of livestock browsing on Arizona cliffrose near Burro Creek with the objective of determining the amount of utilization. Internode distances on five branches were measured on each of 50 Arizona cliffrose plants. Cages were constructed around 25 Arizona cliffrose plants to prevent browsing by livestock, wild burros, and mule deer. Twenty-five plants were left uncaged to serve as a control. Their results showed that browsing activity resulted in 65% utilization of Arizona cliffrose (BLM 1993). This high level of utilization can reduce plant vigor and fecundity, cause lack of seedling establishment, and change the form class of Arizona cliffrose plants, causing them to look hedged. Under this level of utilization, more palatable, associated plant species may be overutilized, resulting in disturbed ecosystem functions and degraded ecological values. The BLM continued monitoring Arizona cliffrose utilization after a fence was constructed in 1989 to exclude cattle and burros from an approximately one square mile area. This large exclosure included the caged and uncaged plants that had been monitored since 1987. After the fence was built, utilization of the Arizona cliffrose plants dropped to 16% in 1989 and 18% in 1990 (BLM 1993). Utilization of caged plants was similar to uncaged plants. These results indicate that livestock and burros were responsible for most of the browsing activity on Arizona cliffrose. Some browsing continues within the exclosure, probably from mule deer and other wildlife. Livestock and burros may occasionally enter the exclosure if the fence is not maintained. Most plants appear to be responding favorably to the lower levels of browsing. However, it appears that some plants that were very heavily browsed over a long period of time may never recover. Only observational data are available regarding the effects of livestock grazing on the Bylas

Arizona cliffrose population. At the Graham County population, Bingham (1977) noted that no young plants were observed during a one hour search in the grazed open area, whereas juvenile plants were present along an adjacent fenced ungrazed highway right-of-way. In 1986, the BIA (/n litt. 1986) noted that the absence of quantities of dried manure and lack of hoofprints to the north of Highway 70 indicated low grazing pressure. They also noted that Arizona cliff rose plants south of Highway 70 were browsed, probably because nearby Poison Spring offers a source of water for livestock and wildlife. (USFWS, 1995)

**Stressor:** Roads and Utilities (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** All of the Arizona cliffrose populations have roads and/or utility right-of-ways within or near them. The Burro Creek population is divided by a graded dirt road paralleled by the Southern Union Gas Company pipeline and Arizona Electric Power Cooperative Incorporated high voltage power line. The gas pipeline has been in existence since at least 1969 (Butterwick 1979). No estimate of the amount of habitat lost to these developments in the Burro Creek area has been made. The Kinginan Resource Management Plan (Kinginan RMP) (BLM 1993 proposed a one-mile wide utilities corridor that overlies Arizona cliffrose habitat. The BLM may grant right-of-ways through this utility corridor (BLM 1993). A graded dirt road (Forest Road 205) and a gated road (Forest Road 530) passes near one of the three Horseshoe Lake subpopulations. Forest Road 479 passes near a second subpopulation. U.S. Highway 70, a two-lane paved road, bisects the population near Bylas. Numerous paved and dirt roads pass through the Cottonwood population. Highway 89A nearly forms the eastern border and Rocking Chair Road passes through the Arizona cliffrose habitat. Its expansion is being planned. Other roads to access housing or for recreational purposes create a network through the habitat. Roads and trails have direct and indirect effects. Road surfaces constitute lost habitat. The amount of habitat and number of plants lost to roads have not been estimated. Roads can change the local hydrology, affecting the amount of precipitation received and absorbed in a local area, changing the direction and speed of runoff, and perhaps changing erosion rates and patterns. These changes can adversely or beneficially affect survivorship and fecundity of individuals. Soil compaction occurs in areas of moderate to heavy vehicle use. Roads can provide access to ORV and other users that may adversely affect Arizona cliffrose and its habitat. ORVs can destroy young plants, harm mature plants, prevent seedling establishment or seed germination, cause soil compaction, and otherwise disrupt the soil surface. Arizona cliffrose plants have colonized a lightly used vehicle trail on the Coconino National Forest. These plants indicate that Arizona cliffrose in the actively reproducing Verde Valley population can recover after light soil surface disturbance. Unknowingly, local residents of the Verde Valley have been using Arizona cliffrose habitat as a parking lot. The parking area is located at the intersection of Rocking Chair Road and U.S. Highway 89A. The area of impact has been expanding during recent years, increasing the number of plants and amount of habitat already lost. The Coconino Forest Plan (U.S. Forest Service 1987) states that the Forest will manage roads adjacent to the Verde Valley Botanical Area to prevent vehicular intrusion." In the same document, the Forest committed to blocking and obliterating existing roads entering the area within the first ten years of plan implementation. To date, road blocking and obliteration has not yet occurred. (USFWS, 1995)

**Stressor:** Recreation (USFWS, 1995)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** The Cottonwood population is adversely affected by recreation of several types. An unofficial shooting range near the eastern portion of this population on the Coconino National Forest has caused the loss of an unknown number of plants and acres of habitat. Shooters park within an Arizona cliffrose population at the base of a small hill and shoot into the population on the hill. The soil at the well-used parking area and roads leading to the shooting range is compacted and eroding, devoid of vegetation, and probably incapable of supporting cliffrose plants unless restored. The area is used not only by shooters, but also by nighttime recreationists. In addition to the shooting range, other spots in the Arizona cliffrose Cottonwood population are frequented by night-time recreationists. These “party spots” are generally severely impacted by vehicles, devoid of vegetation, and littered with trash. ORV recreationists drive through the Cottonwood population, in some cases ignoring signs or cutting fences to gain access to prohibited areas. A fence completely surrounds a section of Arizona State Trust land, which was used by ORV users despite trespass notices. The primary damage to Arizona cliff rose habitat in the Cottonwood area has occurred in Township 16 North, Range 3 East, section 36 by vehicles entering the section from the west. The State Land Department has been successful at notifying the offenders and eliminating this use (Denham /n I/U. 1994). Denham and Fobes (1 992d) also noted ORV damage in the southeast corner of Township 16 North, Range 3 East, section 22 and the northeast corner of section 27. The ORV users entered a parcel of private land via the Coconino National Forest and rode across the property. ORVs are not currently a problem at Horseshoe Lake. The Tonto National Forest Plan (U.S. Forest Service 1985) closed the area to ORV use except where posted as open but has minimally enforced the closure. Despite the presence of a nearby lake and campground, ORV use has not yet been reported within the subpopulations. The amount of recreational activity occurring within the core Burro Creek subpopulation is poorly known. Increased recreational activity may occur within the Clay Hills Area of Critical Environmental Concern (ACEC) when the Burro Creek campground is developed (BLM 1993). The Burro Creek site is a wellknown destination for rock collecting enthusiasts. These visitors may affect Arizona cliffrose by turning over rocks and disturbing seedling establishment microsites. They also may occasionally drive short distances across country to reach collecting sites and crush plants. Whether or not these visitors adversely affect Arizona cliffrose is unknown. (USFWS, 1995)

**Stressor:** Control of Insect Pests (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** General pesticides are often used to control cropland insect pests and sometimes used to control rangeland insect pests. Two Arizona cliffrose populations (Horseshoe Lake and Cottonwood) occur very close to lands under cultivation. A private parcel of land near Horseshoe Dam is being cultivated to provide food for livestock. We do not know if pesticides are currently being applied on the cultivated lands near Arizona cliffrose populations. Four Arizona cliffrose populations occur in areas that are grazed. High densities of rangeland pests have never been reported within Arizona cliffrose populations. If problem densities develop, however, they may be accompanied by proposals from Federal and State agencies to apply chemical controls, including general pesticides. General pesticides such as malathion, a commonly used rangeland and cropland pesticide, can drastically decrease target and non-target insect populations. Insect population sizes are regulated by a number of variables, including weather, inter-and intra-

specific competition, vertebrate predators,and insect predators and parasitoids (Belovsky 1989, Wang and Walgenbach 1989, Hostetter et a!. 1989, Dysart and Onsager 1989, Lockwood 1993). General pesticides will kill target herbivorous insects as well as the insect predators and parasitoids that regulate the herbivores. Herbivorous insects and their predators and parasitoids are usually in a dynamic balance, rarely reaching high, damaging densities except in unnatural circumstances such as the introduction of nonnative pests or in association with various agricultural practices including livestock grazing (Auerbach 1991, Brusven and Fielding 1989, Belovsky 1989). For a review of the field experiments and models of arthropod predator-prey systems that demonstrate this dynamic ecosystem balance, see Hassell (1978). Herbivorous insects recover more quickly after pesticide applications than do their predators and parasitoids because herbivores tend to have a higher fecundity and shorter generation time. Consequently, herbivorous species will more quickly become resistant to chemicals, and their populations will rebound faster and typically at higher densities because predator/parasitoid controls are lost or reduced. Thus, general pesticide applications tend to exacerbate insect population imbalances rather than resolve them. Concern about applying chemical pesticides within or near endangered plant populations has tended to focus on the adverse effects of pesticides on pollinators. For plants that depend on insects for pollination, seed set may be drastically reduced when pollinator populations are reduced by pesticides (Tepedino and Griswold 1989). Avoiding the blooming period of endangered plants may not remove these adverse effects. Fitts et a!. (1993) provide the following explanation: It is obvious that, for the plant, the most dangerous time to spray is during the blooming period. It is less obvious that it may also be risky to spray when bloom is past; many important pollinators are either eusocial, or multivoltine species, i.e., adults are present throughout the growing season, foraging on other plants. These adults are the progenitors of the next years' pollinator crop; removing them will eliminate progeny and, thus the number of pollinators flying in the following year. Information needed to effectively manage insects as part of the ecosystem containing Arizona cliffrose includes the Identification of all insects beneficial to Arizona cliffrose, including pollinators, and an understanding of their life histories and habitat needs. Until such information is obtained, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service has agreed to restrict certain pesticides within a 4.8 km (three-mile) radius of Arizona cliffrose populations. (USFWS, 1995)

**Stressor:** Herbicides (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbicides are sometimes used to control plant growth along paved roads. Although paved roads pass through the Verde Valley and Bylas Arizona cliffrose populations, we do not know if herbicides are used there. Herbicides should not be used along roadsides within Arizona cliffrose populations because treated plants are destroyed. (USFWS, 1995)

**Stressor:** Inundation (USFWS, 1995)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Arizona cliff rose plants and habitat were probably inundated when Horseshoe Dam and its spillway were built on the Verde River in 1944-1946 (FraserDesign 1991). Additional plants and habitat were probably lost when the conservation pool level of Horseshoe Lake was raised in the 1950's to the current elevation of 618 in (2,026 feet). Habitat inundation most likely

occurred in the Chalk Mountain area. If the height of the conservation elevation is increased further, the action would probably inundate additional plants and habitat. The Salt River Project, a utility company, operates the reservoir on a daily basis without specific approvals from Reclamation (Project Manager, Arizona Projects Office, Bureau of Reclamation, in !itt. 1994). (USFWS, 1995)

**Stressor:** Habitat Loss (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In our 2013 5-year review, we reported that the proposed Bella Montaña Residential Community Development, a 283-hectare (700-acre) parcel, would remove 47 cliffrose plants in the eastern-most known extent of the Cottonwood Recovery Unit (USFWS 2007). We also reported conservation measures proposed as a part of the development to protect and enhance cliffrose habitat (USFWS 2007). At the time of this review, the development has not occurred yet, but the consultant for the project has notified us that the project proponent plans to move forward on this project in the near future (N. Sanders, pers. comm., 2021). The original Coconino National Forest Land and Resource Management Plan (Forest Plan) stated that the Forest Service would withdraw the Verde Valley Botanical Area, which contains approximately 50 to 60 percent of the plants in the Cottonwood Recovery Unit, from locatable mineral entry within 10 years of the implementation of the Forest Plan (USFS 1987). To date, the Forest Service has not completed this withdrawal. However, the current Forest Plan indicates that the Cottonwood Recovery Unit has low potential for mining activity and includes a guideline that botanical areas and areas with federally threatened or endangered species be considered for no surface occupancy or mining leases (USFS 2018) (USFWS, 2022).

**Stressor:** Herbivory (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In our 2013 5-year review, we stated that the grazing allotments that contain the Horseshoe Recovery Unit were not active, and these allotments remain inactive. In their revised Land Management Plan, the Tonto National Forest included 3,590 acres, encompassing all the known occurrences of cliffrose in the Horseshoe Recovery Unit within the Horseshoe Recommended Botanical Area (USFS 2022). The Forest Service manages Botanical Areas to maintain or enhance their unique characteristics. Management standards for Recommended Botanical Areas prohibit livestock grazing, mineral extraction, and camping. Additional management guidelines restrict other activities unless necessary to restore or maintain natural conditions or protect natural resources. The finalization of the Horseshoe Botanical Area would address Recovery Actions 1b and 3b. In our 2013 5-year review, we reported that the BLM constructed a fence around the Clay Hills Research Natural Area of Critical Environmental Concern in 1989 to protect the Burro Creek Recovery Unit from the threat of herbivory by livestock and feral burros. After fence construction, browsing utilization of cliffrose decreased from about 65 percent to about 16 to 18 percent (Reichenbacher and Anderson 2022). The BLM continues to monitor the condition of the fence (USFWS 2013) and repaired damaged sections in late 2021 through early 2022 (J. Acton, pers. comm., 2022). Heavy browsing on cliffrose by native ungulates (e.g., mule deer [Odocoileus hemionus]) is evident in the Burro Creek and Horseshoe recovery units. This might be especially prevalent during drought conditions when ungulates

browse on a wider variety of available plants because of limited forage (Reichenbacher and Anderson 2022) (USFWS, 2022).

**Stressor:** Climate Change (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In our 2013 5-year review, we identified climate change as a threat to the cliffrose, specifically through decreased seedling recruitment in response to increased aridity and decreased precipitation (USFWS 2013). Climate modeling for 2050 through 2074 projects that increased temperatures will lead to increased monthly mean vapor pressure deficit in Arizona (Alder 2014); thus, cliffrose will continue to experience drought conditions. While we have little quantitative data showing past effects of drought on vegetation in cliffrose habitat, photographs from 2022 repeated at photo points from the 1980s and 1990s in the Burro Creek, Cottonwood, and Horseshoe recovery units show increased dead shrubs and increased dead branches on shrubs, including cliffrose individuals (Reichenbacher and Anderson 2022). Most cliffrose plants in the three recovery units recently observed (Burro Creek, Cottonwood, and Horseshoe) have not flowered in two years and exhibit signs of stress (Reichenbacher and Anderson 2022) (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
We will consider Arizona cliffrose for downlisting when: (USFWS, 2019)

1. A single, long-term monitoring plan for all Arizona cliffrose populations and habitat is developed and implemented. (USFWS, 2019)

2. Land managers conserve existing habitat, in each recovery unit, in perpetuity to prevent further habitat loss and/or degradation. (USFWS, 2019)

3. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 10 years. (USFWS, 2019)

Recovery Priority Number: 8

**Delisting Criteria:**
In addition to meeting downlisting criteria 1 and 2, we will consider Arizona cliffrose for delisting when: (USFWS, 2019)

1. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 20 years. (USFWS, 2019)

**Recovery Actions:**
- Produce and implement management plans for each of the four recovery units. This recovery task must be completed before recovery criterion 3 can be met. Commitment of the appropriate Federal and State land management agencies and the San Carlos Indian Community towards managing this sensitive habitat is critical to the recovery and survival of

Arizona cliffrose. If new populations are found, management plans covering those populations should be produced and implemented. (USFWS, 1995)

- Initiate research and other actions needed to monitor the species' status and guide recovery efforts. Best management efforts are guided by good biological and ecological information. Currently, too little is known about Arizona cliffrose to determine the most appropriate management actions to effect recovery and determine population stability. Research, studies, and other actions are needed to provide a sound basis for management. (USFWS, 1995)
- Eliminate or minimize threats to the species. Threats which prevent the recovery of Arizona cliffrose should be eliminated. The most important current threats to Arizona cliffrose are habitat loss due to mineral exploration and development, urbanization, recreation, roads, and utilities, and habitat degradation due to livestock grazing and recreation. Reducing or eliminating these and all other threats will lead to the recovery of Arizona cliffrose. (USFWS, 1995)
- Enforce and apply existing laws and regulations. Full use of all Endangered Species Act regulatory control should be used to manage and protect Arizona cliffrose populations. Arizona State law should also be applied and enforced. (USFWS, 1995)
- Information and education. Exchange of information and ideas among private landowners, the scientific community, the public, and Federal, State and local agencies is essential to a successful recovery program. Scientific information, including results of field and greenhouse research, monitoring data, trip reports, agency reports, and scientific literature should be readily available to all parties interested in the management and survival of Arizona cliffrose. Ideas should be freely exchanged so that optimal recovery strategies can be outlined and implemented. Meetings of interested parties to discuss new information or management issues or strategies should be encouraged. Preliminary or refined research or monitoring data should be presented at local, regional, and national gatherings of professional scientists so that a broad professional audience may have opportunities to comment on, and potentially enhance, recovery of Arizona cliffrose. (USFWS, 1995)
- Recommendations for Future Actions from 2013 5-Year Review: 1) We recommend the development or completion of management plans for the Cottonwood population (including the VVBA), the Horseshoe Lake population, and the Bylas population. The plans for each of these populations would be developed by the respective land managing agency (CNF, TNF, and the San Carlos Apache Tribe) with the offered assistance of the USFWS. These management plans should address newly understood or emerging threats such as climate change and invasive weeds. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 2) We recommend the appropriate agencies analyze the monitoring data they have collected to date to determine demographic trends in their respective P. subintegra populations. This will allow the USFWS to determine whether a given population is viable or on a trend toward viability, in support of downlisting criteria one. The USFWS can assist in coordinating this effort to facilitate consistency and comparability between the various monitoring methods employed by each agency. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 3) We recommend the modification or addition of standardized long-term demography monitoring techniques to existing monitoring schemes, or the establishment of standardized long-term monitoring protocols within all four populations. The USFWS can facilitate this process and assist in monitoring design and coordinating standardization between agencies. (USFWS, 2013)

- Recommendations for Future Actions from 2013 5-Year Review: 5) We recommend that the terms “viability” and “significant upward trend towards viability,” as used in the first downlisting criterion, be defined or described for P. subintegra for the purpose of developing an objective and measurable criterion. The USFWS will lead this effort in coordination with land managing agencies and subject matter experts. (USFWS, 2013)
- Since 1989, when a fence was set around the main Burro Creek subpopulation, the BLM has continued to monitor grazing on P. subintegra in the main population as well as the two subpopulations. Herbivory of P. subintegra has been low within the ACEC, recorded at 3 to 9.4 percent utilization for the past six years (Peck 2009b; Peck 2012). Grazing use in the two outlier populations has also been low, ranging from 2.5 to 8 percent. The BLM had predicted livestock grazing at these sites would be light because cattle would be less likely to travel in the area due to the rugged terrain and distance from water. Evidence of herbivory at all sites has been attributed to wildlife, and is well below the trigger of 20 percent for determining if reinitiation of formal consultation is necessary (Hall 1993). The ACEC fence is inspected annually and repaired as needed. The VVBA is within the Windmill Allotment. Section 7 consultations with the CNF were conducted in 1992 and 1997 for the Windmill Allotment Management Plan. Grazing has been excluded from the Rocking Chair and Cornville pastures since 1992, while seasonal grazing has continued in the Gyberg pasture under a deferred rest rotation system (USFWS 1995). Range inspection memoranda, from 2001 to 2006, state that there was light to no use of P. subintegra within the North Gyberg Pasture. The Horseshoe Lake P. subintegra population on the TNF is contained within three grazing allotments. Current management in the Sears Club/Chalk and the St. Clair allotments is non-use due to the allotments being vacant (Willard, pers. comm., 2012). The Sears Club/Chalk Allotment, which contains most of the population, is scheduled for evaluation, under the National Environmental Policy Act, in 2013. The three pastures in the Cartwright Allotment (Lime Creek, Professor, and Long Canyon) have been removed from grazing (USFS 2008). Currently, the threat from grazing appears to be at a low level at three of the populations; the level of grazing effects at the Bylas population is not quantified to our knowledge.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • We recommend the development or completion of management plans for the Cottonwood population (including the Verde Valley Botanical Area), the Horseshoe Lake population, and the Bylas population. The respective land managing agency (Coconino and Tonto National Forests, and the San Carlos Apache Tribe) would develop these plans with the offered assistance of the Service. These management plans should address newly understood or emerging threats such as climate change and invasive weeds. This action would address Recovery Action 1. • We recommend the land management agencies (i.e., BLM, Coconino and Tonto National Forests, and the San Carlos Apache Tribe) implement long-term demographic monitoring within all four populations. This will allow the Service to determine whether a given population is viable or on a trend toward viability. The Service can assist in coordinating this effort. This action would address Recovery Action 2c. • We recommend continued research on pollination, seed germination and seedling establishment, propagation, comparison of recruitment rates among populations, life history characteristics, and growth rates to better understand the threats of and potential measures to address climate change. This action would address Recovery Action 2. • We recommend land managers consider caging seedlings during years of high seed production (i.e., years of moderate or high precipitation) to increase recruitment of seedlings into the juvenile stage (Maschinski et al. 2004; Haskins et al. 2018). This action would address Recovery Action 3. • We recommend collecting seed representing each of the four recovery units, with regular supplemental collections, and maintaining the collection in at least one Center for Plant Conservation partner botanical or seed storage institution. We did not include biobanking as a recovery action in the Recovery Plan. However, after we completed the Recovery Plan in 1995, researchers improved techniques and knowledge that increase the potential contribution of biobanking to cliffrose conservation. We therefore include this recommendation to preserve some of the species' genetic diversity for potential future population augmentations or reintroductions (USFWS, 2022).

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# SPECIES ACCOUNT: *Rhodiola integrifolia ssp. leedyi* (Leedy's roseroot)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 04/22/1992; Great Lakes-Big Rivers Region (R3) (USFWS, 1992)

**Physical Description**

Leedy's Roseroot is a perennial herb with multiple leafy stems from a scaly root crown that is usually visible in the rock crevices where the plants are growing. Leaves are glaucous, oblong, blue-green, and thick-succulent, with irregularly toothed to entire margins. The dark red and yellow flowers (May-August) are arranged in rounded clusters at the ends of the stems. (NatureServe, 2015)

**Taxonomy**

Listed as a subspecies of Sedum integrifolium, a revised scientific name of Rhodiola integrifolia ssp. leedyi, as treated by Kartesz (1999) was accepted by the USFWS in 2010 (USFWS, 2010).

**Historical Range**

Apparently the Leedy's roseroot is not known to have occurred in historical times in other locations than present. (USFWS, 2015)

**Current Range**

Leedy's roseroot is found today in only six locations in two widely separated states. Four populations of several thousand plants each are found in Fillmore and Olmsted Counties, Minnesota. The other two are in upstate New York, a large population on the shores of Seneca Lake and a single plant at Watkins Glen. (USFWS, 2015). Also occurs at Harney Peak, Black Hills National Forest, South Dakota (Olfelt and Freyman 2014, p. 908). (USFWS, 2015b).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Usually sexual reproduction; some vegetative (USFWS, 1998)

**Dependency on Other Individuals or Species**

Adult: Bees and syrphus flies as pollinators (USFWS, 1998)

**Breeding Season**

Adult: Flowers in June (USFWS, 1998)

**Other Reproductive Information**

Adult: Olfelt (1998, p. 16) found a seed germination rate for Leedy’s roseroot of 77% and described this as high for a rare plant, but lower than that of related subspecies. (USFWS, 2015b).

**Reproduction Narrative**

Adult: Flowering occurs in early June. Clausen (1975) reports bees and syrphus flies as pollinators; Sather (1993a) observed bees on New York plants. Seeds are winged and adapted for wind dispersal. Seeds produced by plants at Glenora Cliff, New York, sometimes germinate in their follicles and produce seedlings on the parent plant (Clausen 1975). Plants grown in a Minnesota greenhouse from seed flowered their first season after germination (Joel P. Olfelt, University of Minnesota, pers. comm. 1996). Although, newer growth on the long-lived rootstocks breaks off to form clones, which have lived at least 36 years in cultivation (Clausen 1975), Olfelt and Luby (in press) report finding little clonal reproduction. Of 81 stems they assayed, 75 had unique markers, indicating those 75 stems had not been produced by cloning. (USFWS, 1998)

**Habitat Type**

Adult: Cliff ledges and talus slopes (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Ground water or cool air (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from USFWS, 1998)

**Environmental Specificity**

Adult: Very narrow specialist (USFWS, 1998)

**Habitat Narrative**

Adult: The habitat is limited to north or east-facing talus slopes or cliff ledges where ground water (primarily in New York) or cool air (primarily in Minnesota) constantly seep through the strata or between the rocks, maintaining a cool, wet environment throughout the summer. (NatureServe, 2015; USFWS, 1998)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (inferred from USFWS, 1998)

**Dispersal**

Adult: Wind dispersal of seeds (USFWS, 1998)

**Dispersal/Migration Narrative**

Adult: Plants are specific to a particular habitat which limits dispersal. The preferred cold air cliff faces with seepages are rare. (USFWS, 1998)

***Population Information and Trends***

**Population Trends:**

Unknown. Inferred from information (USFWS, 2021)

**Number of Populations:**
6 (USFWS, 2015)

**Population Size:**
>4,000 individuals (USFWS, 2021)

**Adaptability:**
Low (inferred from NatureServe, 2015)

**Population Narrative:**
Populations may be increasing or decreasing (NatureServe, 2015). USFWS (2015) indicates that the four Minnesota populations have several thousand plants each, but NatureServe (2015) indicates only 1500-2000 plants in all Minnesota populations. The New York population at Seneca Falls consists of "a large population" (USFWS, 2015) or "several thousand plants" (NatureServe, 2015). There is one plant at Watkins Glen, NY; it is likely introduced. (USFWS, 2015; NatureServe, 2015). The South Dakota population of Leedy's roseroot occurs on Black Hills National Forest on a cliff at approximately 7,000 feet above sea level. White spruce (Picea glauca) is the dominant overstory species on the north-northeast facing slope directly below the cliff; and ponderosa pine (Pinus ponderosa) is the dominant tree species in the general vicinity (U.S. Forest Service, in litt.). About seven patches of Leedy's roseroot may inhabit only a total of 10-50 square meters of the cliff face (Fig. 4; U.S. Forest Service, in litt. 2001; 2011). (USFWS, 2015b). The most recent census data indicate that the population at the Glenora Cliffs site in New York has increased since the most recent census and remains above 4,000 plants. At the Glenora Falls site, the population of 45-50 plants did not change between 2017 and 2020. The single individual that makes up the Watkins Glen State Park population in New York was inadvertently destroyed during construction of a new trail. Partners at the State University of New York College of Environmental Science and Forestry have applied for Section 6 funding to collect seeds from plants at New York sites, propagate Leedy's roseroot in a greenhouse environment, and outplant individuals at Watkins Glen State Park (Wiley (NYFO) pers. comm. January 27, 2021). All Minnesota populations have increased since the most recent census in 2020, although overall trends since 1997 are mixed with the Whitewater WMA population declining and populations at Simpson Cliffs, Deer Creek, and Bear Creek being relatively stable (Olfelt 2020a; Appendix B). No changes were noted for the South Dakota population of Leedy's roseroot in 2016 and 2017 (USFWS, 2021).

***Threats and Stressors***

**Stressor:** Ground water contamination (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Contamination of ground water is likely though filling or dumping in sink holes adjacent to the cliffs. Sink holes are highly vulnerable because they provide direct access to the ground water and are the main source of seepage on the cliffs. (USFWS, 1992)

**Stressor:** Agricultural pesticides (USFWS, 1992)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** The use of agricultural pesticides in adjacent upland farmland (cropland in Minnesota and vineyards in New York) may directly affect the quality of the ground water. (USFWS, 1992)

**Stressor:** Residential development (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In New York, homes are being built above the cliffs. Many homeowners have built stairs down the cliffs to Seneca Lake and some have cleared vegetation from the cliff or cut trees at the top of the cliff to enhance the view. Some trees have been simply dumped over the cliffs. (USFWS, 1992)

**Stressor:** Road building and quarrying (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Road building and quarrying in the karst region of Minnesota would affect the subsurface water flow in an area and change the required groundwater seepage at a cliff face. (USFWS, 1992)

**Stressor:** Erosion and rock slides (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The slopes where the roseroot occurs are unstable. Natural erosion of the cliffs occurs and may denude the vegetation. Heavy runoff may directly dislodge plants from cliffs or may result in gullies being cut into a population site. Logging above some of the Minnesota sites may also cause erosion affecting the cliffs. (USFWS, 1992)

**Stressor:** Grazing (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Grazing may damage plants on the lower, gentler slopes of the cliffs where dislodged plants have again taken root.

**Stressor:** Climate change and catastrophic wildfire (USFWS, 2015b).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Leedy's roseroot already inhabits the highest elevation habitat available in the ecoregion and would not be able to move to higher – and presumably cooler and moister – habitats if climate change rendered its current habitat unsuitable. In addition, as ponderosa pines succumb to mountain pine beetle, drop needles, and fall the risk of a wildfire in forest around the Leedy's roseroot population is likely to increase (C. Monks, pers. comm. 2014). (USFWS, 2015b).

***Recovery***

**Delisting Criteria:**
All three privately owned Minnesota populations must be protected by conservation easements or fee acquisition by a public agency or private conservation organization. (USFWS, 1998)

The Whitewater Wildlife Management Area, Minnesota, population must be protected from or removed from any confirmed contamination threat and has been demonstrated to be self-maintaining for five years. (USFWS, 1998 and USFWS 2021)

The Glenora Falls, New York, population must be protected. (USFWS, 1998)

Habitat for 4,000 plants in multiple sites, evenly distributed along a 2-mile stretch of Glenora Cliff, New York, must be protected. The two most-distant subpopulations protected at Glenora Cliff must be at least 1.5 miles apart. (USFWS, 1998)

Protected populations must be geographically distinct, self-sustaining, and have been protected for five consecutive years by measures that will remain effective following delisting. (USFWS, 1998)

**Recovery Actions:**
- Map all populations, and identify all affected landowners. (USFWS, 1998)
- Determine hydrologic relationships between upland areas and S. integrifolium ssp. leedyi populations. (USFWS, 1998)
- Establish and administer a permanent infrastructure for Leedy's roseroot site protection and secure funding for that protection. (USFWS, 1998)
- Contact landowners, landowner associations, and land trusts; secure their involvement in conservation strategies; compensate them for costs of fee acquisition, enrollment in conservation easements or other programs; prepare management plans for public and private protected areas. (USFWS, 1998)
- Establish, implement, and review a monitoring program. (USFWS, 1998)
- Provide public education, including advance landowner contact. (USFWS, 1998)
- Develop and maintain a genetic bank. (USFWS, 1998)
- 2015 recommended actions - 1. Review threats to the species, beginning with the information in this review, to ensure that recovery criteria are revised appropriately to address all significant threats to the species. Prepare a list of threats based on this assessment and have it reviewed by species' experts to ensure that it is complete and accurate. Finally, revise the recovery criteria, as appropriate. (USFWS, 2015b).
- 2015 - 1.1: Determine whether and to what degree any Leedy's roseroot populations are threatened by the instability of their cliff side habitats and whether heavy rains are likely to pose a threat any population. Use this information to determine whether the recovery criteria should be revised to address specific related threats and revise the criteria, if appropriate. (USFWS, 2015b).
- 2015 - 1.2: Determine whether and to what degree any Leedy's roseroot populations are threatened by gully formation or by poor soil conservation practices. Revise the recovery criteria to address this factor if it poses a threat. This potential threat may currently be most relevant to the population at Whitewater Wildlife Management Area in Minnesota. (USFWS, 2015b).

- 2015 - 1.3: Determine whether grazing or logging poses a direct or indirect threat to any Leedy's roseroot population. If they do, revise the recovery criteria to ensure that no site is considered to be protected unless the threats are adequately minimized. (USFWS, 2015b).
- 2015 - 1.4. Consider revising the recovery criteria to clarify that the protections required for each Leedy's roseroot population must preclude the following: 1.4.1. Filling or dumping material into any sink holes where that activity could result in exposure of Leedy's roseroot to harmful contaminants or alteration of groundwater flows to cliffs where Leedy's roseroot occurs; 1.4.2. The use of any pesticides or herbicides where it would result in the exposure of Leedy's roseroot to harmful compounds; and, 1.4.3. Road building or quarrying that would affect groundwater flows in any Leedy's roseroot cliff side habitats. (USFWS, 2015b).
- 2015 - 1.5: Consider revising the recovery criteria to require that protection of Leedy's roseroot habitat at the Glenora Cliff site in New York would preclude the construction of stairs, vegetation clearing (except for invasive species), laying of pipes, and dropping felled trees where these activities would likely cause adverse effects to Leedy's roseroot. (USFWS, 2015b).
- 2015 - 1.6. Consider revising the recovery criteria to further clarify that the populations around Seneca Lake must be protected from residential development, cliff-face alteration, and hydraulic fracturing (fracking) that could affect ground water quality and flow. (USFWS, 2015b).
- 2015 - 1.7. Review the preliminary hydrogeological assessment prepared for Leedy's roseroot in Minnesota (Spetzman and Cremers 1999) and develop a plan to assess the risk of groundwater contamination for each of the four Minnesota populations and measures that would protect the taxon from this threat. Consider engaging the appropriate regional hydrologist with the Minnesota Department of Natural Resources, Division of Ecological and Water Resources to help develop this plan. Ensure that the plan is sufficient to determine the following: 1.7.1. The extent to which transport of agricultural chemicals into sinkholes poses a risk of exposing Leedy's roseroot to contaminated groundwater. 1.7.2. The locations of sinkholes – or the areas in which they may occur – that should be protected to ensure that each Leedy's roseroot population is safe from effects to groundwater flows or groundwater contamination. 1.7.3. The area in which road building or quarrying may expose Leedy's roseroot to the effects of any changes in groundwater discharge. 1.7.4. The specific practices that would need to be implemented to mitigate any specific threats of exposing Leedy's roseroot to changes in groundwater discharge or to contaminated groundwater and to alleviate any ongoing exposure. It may also be prudent to carry out similar actions in New York. (USFWS, 2015b).
- 2015 - 2. Revise the recovery plan to address the Leedy's roseroot population that is now confirmed in South Dakota. (USFWS, 2015b).
- 2015 - 3. It may still be unclear whether the taxon may be conserved by relying only on the protection of the seven known extant populations. The seven populations include four in Minnesota; two in New York; and, one in South Dakota. Consider developing a range wide viability assessment that assesses the species' recovery criteria and determines whether extant populations would ensure sufficient redundancy and representation for the subspecies; and to develop criteria that may be used to determine whether or not the populations that are essential to recovery are sufficiently resilient. (USFWS, 2015b).
- 2015 - 4. Define "self-sustaining" per the recovery criteria or eliminate it from revised criteria. (USFWS, 2015b).

- 2015 - 5. Ensure that an adequate seed banking program is established for Leedy’s roseroot. (USFWS, 2015b).
- Enrollment in permanent conservation easements, private land trusts, or landowner associations with effective land management plans to minimize impacts on S. integrifolium ssp. leedyi populations. (USFWS, 1998)
- Acquisition of fees to provide tax relief or other compensation to landowners. (USFWS, 1998)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: • Manage each population as a unique management unit o Prioritize conservation of large population centers at the Glenora Cliffs and WWMA sites o Prioritize conservation of genetic diversity at the Deer Creek site by collecting seeds • Evaluate abiotic and biotic factors associated with Leedy’s roseroot in New York, Minnesota, and South Dakota sites o Use information to develop management recommendations • Revise recovery criteria to address threats related to cliff instability and heavy rains • Conduct DNA microsatellite analysis on South Dakota population and additional populations in New York (USFWS, 2021).

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# SPECIES ACCOUNT: *Rhododendron chapmanii* (Chapman rhododendron)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 5/23/1979; Southeast Region (R4)

**Physical Description**

Chapman's rhododendron is a small (0.5 - 2m in height), evergreen shrub with stiffly ascending branches. Leaves are alternate, 3 to 6cm long, obovate with tapered bases, obtuse or rounded apices, somewhat wrinkled, and with entire but curled undermargins. Shade leaves are less wrinkled and curled. Petioles are from 2 to 6mm long. New stems, petioles and under surface of leaves are usually scurfy, dotted reddish brown. Flowers, borne in terminal clusters, have light pink, funnel-shaped corollas about 3cm long with 5 fused petals. Fruit capsules, about lcm long, are borne in clusters which persist several years and are present on almost all plants. It blooms prolifically with large clusters in late March to early April. (USFWS, 1983)

**Taxonomy**

Asa Gray (1877) described R. chapmanii and credited Chapman (1860) with recognizing the taxon as a variety growing in the sandy pine barrens of west Florida (Duncan and Pullen, 1962). Recent authors treat as R. minus var. chapmanii (Godfrey, 1988; Duncan & Pullen, 1962; Luteyn et al., 1996). Kartesz (1994) treats as full species. R. minus var. minus occurs in Georgia and southern Appalachians (Duncan & Pullen, 1962) (NatureServe, 2015).

**Historical Range**

Endemic to Florida, in Gulf, Liberty, Gadsden, and Clay counties. (USFWS, 2019a)

**Current Range**

Endemic to Florida and restricted to Gulf, Liberty/Gadsden and Clay counties. (USFWS, 2019a)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Blooms in mid-March to early April (USFWS, 2019a)

**Reproduction Narrative**

Adult: Although R. chapmanii flowers and fruits abundantly, no seedlings were observed in the 1996 monitoring event (author, pers. obs.), and only one was found in the 1985 monitoring event (Hardin, et al., 1985). Plants are grown from seed for the nursery trade (Hardin, et al., 1985), so presumably they are reasonably easy to germinate and grow in captivity.; Ann Redmond made notes and diagrams of five plants that she excavated to a depth of ca 20 cm near the permanent monitoring plots in Gulf and Liberty/Gadsden counties (Redmond, 1985).

She observed that clumps of stems, which would have been considered several "plants" for monitoring purposes from an above-ground point of view, often were found to arise from the same underground rootstock when excavated. Thus there were actually fewer genetic individuals present than there were stem clumps tagged. She also noted evidence of areas in the rootstock where former stems had died and rotted away and evidence of grafting between stems from different sources. From her rough diagrams it appears that the underground biomass of rootstock plus roots would exceed the biomass of the aboveground stems. All of the excavations showed rhizomes heading out from the central rootstock to beyond the area of the excavation which generally covered an area of less than 1 square meter. PHENOLOGY: Rhododendron chapmanii has a fairly narrow two to three week flowering period which may begin from mid- March to early April (Duncan and Pullen, 1962; Hardin et al., 1985; Schultz and Johnson, 1996). A hard freeze in January and March 1985 may have delayed and reduced flowering in that year by killing the buds (Hardin, et al., 1985) (NatureServe, 2015).

**Habitat Type**

Adult: Bbetween upland mesic or scrubby flatwoods and floodplain swamps or baygalls; mesic pine flatwoods (USFWS, 2019a)

**Habitat Vegetation or Surface Water Classification**

Adult: Terrestrial

**Dependencies on Specific Environmental Elements**

Adult: Acidic sandy soil (USFWS, 2019a)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2019a)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Rhododendron m. chapmanii usually occurs in a transitional area between upland mesic or scrubby flatwoods and floodplain swamps or baygalls. This species is also found within mesic pine flatwoods or on the lower elevations of the sandhills. Consequently, it appears to require acidic sandy soil, good to moderately welldrained to somewhat poorly drained sandy soils of 0-5% slope, and no flooding. The Camp Blanding population grows on the edge of xeric hammock next to a stream bank. The plants tolerate full sun to moderate shade (Negron-Ortiz, 2010, pers. observ.), and heavy shade once they are mature as at Camp Blanding (Hall 2005). (USFWS, 2019a)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Declining (USFWS, 2019)

**Number of Populations:**

4 (USFWS, 2024)

**Population Size:**

approximately 3,000 clumps (USFWS, 2019a)

**Population Narrative:**

Rhododendron m. chapmanii is restricted to the Florida panhandle with only three known opulations occurring in coastal Gulf County, Liberty and Gadsden counties in the vicinity of Hosford, and Clay County on the Camp Blanding Military Reservation. The population near Hosford is the largest and is privately owned by AgReserve Inc., which may maintain timber production and agricultural uses of the lands. The smallest and most geographically isolated of these populations is within the Florida National Guard post at Camp Blanding, about 165 miles east of the Hosford population. Throughout Florida, surveys and censuses collectively recorded about 55 occurrences or sites. Although we have limited information regarding trends, current data assessment suggest the presence of only 35 sites (about 36 % decline). In May 2019 FNAI performed a comprehensive review of all R.m. chapmanii element occurrences (EO2). The 55 areas where the species was observed are currently mapped as 23 EOs. This is based on NatureServe 2004 guidance (EO separation distance of 1 km) with the addition of separation based on differences in management practices, threats, and habitat conditions. If considering only the parameter of 1 km separation distance, the 23 EOs technically represent 15 EOs (J. Annis, FNAI, 07/02/2019, pers. comm.). (USFWS, 2019a). Rhododendron chapmanii is a small evergreen shrub presently comprised of four populations located in five Florida counties four of which are in the panhandle. A new occurrence was recorded in 2022, increasing the total occurrences to 16 and extending the geographic range 80km northwest from the nearest known population (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Urbanization (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In addition to being one of the largest private landowners in northwest Florida, the St Joe Company is also one of the largest real estate operating companies in the Southeast. This Company develops both residential and commercial properties along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2070 along with a growth of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Since the species occurs on Company-owned property in Gulf, Liberty, and Gadsden counties, Florida, there is no guarantee that these properties will not be utilized for residential or commercial development in the near future. Therefore, residential or commercial development is a threat. (USFWS, 2019)

**Stressor:** Forestry practices (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The timber industry in North Florida became well established in the 1850s. Privately owned companies grow trees for their byproducts by mechanically preparing the site for

planting, planting seedlings, and mechanically harvesting the trees. Harvesting typically involves thinning, and later clear cutting the site; the process is then repeated. The St. Joe Company had close to a million acres in timber in the eastern region of the panhandle and they plan to continue to harvest and replant indefinitely. Tree farming, i.e., privately owned forest managed (clearcutting, mechanical site preparation, and pine plantations) for timber production, is a primary threat since there are many thousands of acres of tree farms. In 2013, the St Joe Company sold more than 380,000 acres of its land to AgReserves, Inc., a for-profit company that has primarily focused on cattle grazing. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. The safety of the Hosford population, sold to AgReserves, Inc., is undetermined because it is not protected. Also, the Gulf County population is primarily on tree farm land; therefore, tree farming is a threat to this species. (USFWS, 2019)

**Stressor:** Fire suppression (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Suppression of fire continues to threaten pineland and savanna flora as fire is an important element in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Prescribed burnings are needed to maintain optimal habitat for R.m. chapmanii populations; specifically to avoid the encroachment of Cyrilla racemiflora L. (swamp titi). (USFWS, 2019)

**Stressor:** Drainage (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Drainage of adjacent bogs to increase areas of pine plantings affects seasonal hydrology. Drained sites become more desiccated, and this affect processes such as seed germination and seedling establishment. Therefore, drainage of adjacent bogs is still a threat due to tree farming activities. (USFWS, 2019)

**Stressor:** Overutilization (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** The Recovery Plan identified this as a threat to R.m. chapmanii. Specifically, the Plan suggested that this species was taken from the wild for ornamental purposes (Tatum and Lake 1979). According to Simmons (1983), numerous plants were removed in the late 1940's from the Camp Blanding for the nursery trade. Similarly, 100-200 plants were removed from the Hosford population (USFWS 1983). Therefore, this species was a 'commercially exploited plant'3 and is still sold by several nurseries (e.g., https://shop.shadygardensnursery.com/). This activity does not currently seem to be a major problem because most cuttings and seeds come from plants collected in the past. However, we cannot discount the possibility of sporadic plant removal.

(USFWS, 2019)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Endangered Species Act (Act) of 1973, as amended prohibits the removal of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in knowing violation of state law or regulations or in the course of any violation of a state criminal trespass law. However, the Act does not provide protection for plants on private lands or unless it's in violation of state law. Several populations of R.m. chapmanii occur on private timberland. While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. Neither section of the Act provides protection for plants on private lands as long as the activity is permissible under state/local laws. Seeds of both threatened and endangered species found on federal lands are regulated under the Act. In addition, the seeds of an endangered species are regulated if they are going to be purchased/traded/bartered in interstate commerce. Since R.m. chapmanii is an endangered species, the seeds are regulated under the specified conditions. However, the seeds are not regulated if they are provided freely (no exchange of money, goods, or services; 7 CFR 319.37.2, USDA 2008). The State requires permission of private landowners for collecting of state-listed plants from their property. Rhododendron m. chapmanii is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). This law does not protect habitat. Based on the information summarized above, the existing regulatory mechanisms are deemed inadequate for plants. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
1. The dense 10-acre population near Hosford is maintaining a stable or increasing population of healthy plants. (USFWS, 1983).

2. The remaining part of the Hosford population continues to occupy at least 200 acres with at least 500 plants. (USFWS, 1983)

3. The Gulf County population continues to occupy at least 200 acres with at least 500 plants. (USFWS, 1983)

4. The Camp Blanding population continues to have at least 20 plants. (USFWS, 1983)

5. There is a permanent increase of about 1,000 plants at any combination of sites 2, 3, and 4 to increase to a total of at least 2,000 plants at these sites. (USFWS, 1983)

Recovery Priority Number: 8C

**Delisting Criteria:**
1. The three (3) existing populations (Hosford, Gulf, and Clay) and their occupied habitat are conserved, restored, and properly managed, and monitoring demonstrates that the populations are stable or increasing over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A and D). (USFWS, 2019b)

2. At least five (5) new populations are discovered or established within the historic range of the species on lands protected by a conservation mechanism, and exhibit stable or increasing trends over multiple prescribed burn cycles, evidenced by a type of recruitment and/or multiple size-classes (addresses Factors A and E). (USFWS, 2019b)

3. Threats (e.g. urban development, timbering, agriculture, inadequate fire management, invasive species) have been reduced and/or managed to a degree that R. m. chapmanii will remain viable into the foreseeable future (addresses Factors A and D). (USFWS, 2019b)

**Recovery Actions:**
- 1. Highest priority for the recovery of Chapman's rhododendron should be to reverse the habitat and population declines that are occurring in the wild population. This can be accomplished through a combination of protection, management and monitoring. Most important in accomplishing this goal is to establish and maintain a strong, friendly and longlasting working relationship with the St. Joe Paper Company, which owns over 99 percent of the wild population and its habitat. The Company has expressed a willingness to help (pers. comm.), and, indeed, has already taken some steps to protect the species and its habitat. Camp Blanding guards the small population there rather closely, and has expressed willingness to help manage the site. (USFWS, 1983)
- 2. Strengthening existing populations by planting nursery-grown plants is clearly less important than habitat protection and management. Tt may nevertheless prove to be essential for long-term survival of the species. Tt provides a tested (plantings have been done by Simons in the wild in Suwannee, Levy and Putnam Counties with 100 percent success rates) and easy method to quickly strengthen a population. (USFWS, 1983)
- 3. Establish new populations. Determine historical range. Locate suitable habitat. Obtain permission and cooperation for establishing planting. Collect seed. Grow plants and plant out in December - January at a 20 by 20 foot spacing (about 100 per acre). (USFWS, 1983)
- 4. Research is the lowest priority, because it seems least important from the standpoint of the immediate and near-term needs of the species. However, the farther one looks into the future, the more important research is. The amount of research recommended here is the minimum necessary to provide for implementation of this recovery plan. (USFWS, 1983)
- The level of occupancy of the three existing populations persists as at least: 5,000 acres for Hosford, 6,000 acres for Gulf County with a minimum of 2,000 clumps, and 30 clumps for Clay County (addresses Factors A and D) and management with prescribed fire is implemented on a 3 to 5 year return interval. (USFWS, 2019b)
- Foster a partnership with the current landowner of the AgReserves, Inc. to promote the protection of the Hosford population (found in Liberty and Gadsden counties) and help implement best management practices (e.g., prescribed fire, mowing/fuel reduction, invasive species removal) (addresses Factors A and D). (USFWS, 2019b)

- A long-term ex-situ conservation program is ongoing to help avert the risk of extinction from stochastic events, environmental catastrophes, or development. The living collection should emphasize the privately owned Hosford population and coastal areas (see Justification of criteria 1 and 3). The collection should be maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach (addresses Factors A and E, and representation). The full genetic diversity represented in the Hosford population needs to be protected through ex-situ management efforts. (USFWS, 2019b)
- The contribution of sexual reproduction to population maintenance is assessed via research related to in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth) (addresses Factors A, D, E, and resiliency). (USFWS, 2019b)
- The genetic composition within and among populations is assessed to clarify species boundaries, define evolutionarily significant units, detect inbreeding, identify clonal reproduction, and determine effective management (addresses Factors A, D, E; informs the ecological principle of representation). (USFWS, 2019)
- Assess the R. m. chapmanii demographic responses (e.g., recruitment, reproduction, and mortality) to hurricane and fire disturbances (addresses Factor E and resiliency). (USFWS, 2019b)
- A comprehensive census is conducted throughout the present distribution and on new locations where appropriate habitat exists (addresses Factor A and redundancy). (USFWS, 2019b)
- Acquisition of the following private lands will benefit the status of this species: - Several land parcels adjacent to the SJSBP, Gulf County that has Chapman's Rhododendron and a suite of other rare species. - The Hosford population located in Liberty and Gadsden counties. (USFWS, 2019a)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution. Follow a standardized method for accurate population counts to ensure consistency in collected data. (USFWS, 2019a)
- Conduct surveys for new populations where similar habitat exists. This action can include the use of aerial photographs and species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. Follow a standardized method for accurate population counts to ensure consistency in collected data. (USFWS, 2019a)
- Garden propagation and reintroduction. An ex-situ seed collection should be actively pursued and implemented to help avert the risk of extinction from stochastic events, environmental catastrophes, or development. The living collection should emphasize the privately owned Hosford population and coastal areas, and maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach. (USFWS, 2019a)
- Complete a population genetic study to determine the levels and distribution of genetic diversity within and among populations of R. m. chapmanii. The study should test whether the Camp Blanding population is an artificial (planted) population. The Recovery Plan deemed it "unlikely" that this population was planted, but this would provide a further test. (USFWS, 2019a)
- The contribution of sexual reproduction to population maintenance is assessed via research related to in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed

germination, seedling survival and growth). (USFWS, 2019a)
- Assess the R. m. chapmanii demographic responses (e.g., recruitment, reproduction, and mortality) to hurricane disturbance. (USFWS, 2019a)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES • Foster a working relationship to establish protection and management agreements with private landowner AgReserve, Inc. • Hosford population: A comprehensive survey is needed to assess the status of the plants and corresponded habitat. This recommendation is a priority. • Conduct surveys/inventories/demographic studies on each known population every five years. Note: Atlanta Botanical Garden initiated a detailed demographic study of Chapman's rhododendron in 2021 at St. Joseph State Buffer Preserve (CP #F20AC10631). • Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated, or in potential suitable habitat suggested by the species distribution modeling developed by FNAI (2022). • Acquisition of land parcels adjacent to the St. Joseph State Buffer Preserve, Gulf County that has Chapman's rhododendron and a suite of other rare species (USFWS, 2024).

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# SPECIES ACCOUNT: *Rhus michauxii* (Michaux's sumac)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015) 9/28/1989

**Physical Description**

A low-growing, densely hairy, dioecious shrub, mostly 0.3 to 0.6 m tall. Leaves are pinnately compound with 7-13 leaflets that are coarsely toothed. Female plants produce erect clusters of greenish-yellow to white 4-5 parted flowers and conspicuous red drupes. Flowers from April to June. Fruits persist from August through September or October (NatureServe, 2015).

**Taxonomy**

Andre Michaux discovered this species on July 20, 1794 in Mecklenburg County, NC (the area is now part of Union County). He named the species Rhus pumila in 1803; however, since the specific epithet pumila had already been used for another species, Sargent assigned the name R. michauxii in 1895 (Barden and Matthews 2004). There have been no changes to the taxonomic classification or nomenclature since Rhus michauxii was listed as endangered in 1989 (USFWS, 2014).

**Historical Range**

Historically endemic to the Inner Coastal Plain and lower Piedmont of North Carolina, South Carolina, and Georgia (USFWS 1989). HISTORIC RANGE: From the time of its discovery in 1895 until 1989, half of the known occurrences of Rhus michauxii have been extirpated (USFWS 1989). Thirty-two occurrences were historically reported from 23 counties in NC, SC, and GA (USFWS 1989). Four occurrences historically known from Cobb, Columbia, Newton, and Rabun counties, GA, are believed extirpated (Murdock and Moore 1991, Patrick 1993). Historical collections are known from Florence, Kershaw, and Oconee counties, SC. Following extensive, unsuccessful searches of their last known locations, as well as other areas of suitable habitat, Michaux's sumac is believed extirpated from the state (USFWS 1989, Murdock and Moore 1991). Historical and/or extirpated NC records exist (year last seen in parentheses) for Durham (1949), Franklin (1914), Hoke (1981), Johnston (1833), Lincoln (prior to 1917), Mecklenburg (pre-1800s), Moore (1901), Orange (1964), Robeson (1982), Wake (1942), and Wilson (1958) counties (Murdock and Moore 1991, NCNHP 1993). Considered extirpated from Florida, where the original collection was made in 1961 in Alachua County (Murdock and Moore 1991). Apparently by 1989 the collection site had been developed and was occupied by at least one residential home. Kathy Burkes of FNAI notes: "Whether the plants seen in 1961 were waifs carried far afield from the Piedmont by humans or other animals in "recent" times, or were true relicts of a former wide distribution reaching south into Florida is another question. We may never know for sure about that." (NatureServe, 2015).

**Current Range**

When the recovery plan was completed in 1993, R. michauxii was believed extant at 21 sites in NC and GA. No populations were known from VA at that time. R. michauxii was believed to be extinct at 20 sites in the coastal plain and piedmont of NC, South Carolina (SC), GA and Florida (FL). Since listing, additional occurrences have been found in GA, NC and VA. As of 2014, there are 43 parent populations, rangewide. The GANHP database currently lists four extant occurrences of R. michauxii and two additional subpopulations are considered historical or extirpated. NCNHP records currently indicate a total of 33 extant populations. An additional 13 sites in NC are now considered historical, extirpated or failed to find. The VANHP database indicates that there are six occurrences extant within the state with no known historical or extirpated populations. This information is summarized in Table 1 and additional information about each element occurrence (EO) is included in Appendix C. Following current NatureServe methodology, some of these sites are now considered sub-populations or sub-sets of larger populations or principal EOs. See Table 1 for an additional explanation of this methodology. Several populations of R. michauxii are now considered historical or extinct, including all previously known sites in FL and SC. Rhus michauxii was collected in Alachua County, FL in 1961. Attempts to relocate this population in 2006 (and prior to 2006) were unsuccessful (Herring 2006). Three sites known from SC (one site each in Florence, Kershaw and Oconee counties) were considered extirpated before the species was federally listed as endangered in 1989. (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual: vegetative (USFWS, 2014)

**Reproduction Narrative**

Adult: Most of the surviving populations appear to contain plants of only one sex and therefore reproduce only vegetatively, if at all. Due to the rhizomatous nature of the species, this may mean that the single-sex populations are clones of one or a few individuals; two populations sampled for genetic diversity by Sherman-Broyles et al. (1992) appeared to each consist of a single clone (USFWS, 1993). Single sex populations that are clonal in nature prohibit sexual reproduction and seed production in this species. In populations where seeds are produced, it appears that seed germination is very low (USFWS, 2014). Although specific pollinators are unknown, Michaux's sumac, like other species in the genus, is probably pollinated by insects. Sherman-Broyles et al. (1992) observed that bees visited the flowers of other sumac species and that birds dispersed the fruits (USFWS, 1993).

**Habitat Type**

Adult: Open Woodland (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Michaux's sumac occurs in sandy or rocky open woods, sometimes in association with circumneutral soils (USFWS 1990). In the fall line sandhills region it occurs in submesic loamy swales. In the eastern Piedmont, it occurs on sand soils derived from granite. In the central Piedmont, it occurs on clayey soils derived from mafic rocks (Weakley 2004). In all of its habitats, Rhus michauxii is dependent upon some form of disturbance to maintain the open quality of its habitat (USFWS 1989). Periodic, naturally occurring fires provided such disturbance historically. Today, however, many of the Michaux's sumac occurrences are in areas that are artificially disturbed, such as highway and railroad rights-of-way, pine plantations, edges of cultivated fields, and other cleared lands (USFWS 1989, TNC 1991-93, NCNHP 1993, Center for Plant Conservation 2002). Although roadside occurrences appear to be thriving in the presence of some level of disturbance (i.e., mowing), they are always under the constant threat of catastrophic disturbance. Roadbed widening or heavy equipment activity on cleared lands, for example, may dramatically reduce the number of individuals. These reductions, if they come at a crucial stage in the species' reproductive cycle (i.e., during flower or fruit production), could have severe long-term effects on the population. Although it appears that Michaux's sumac can rebound from large disturbances, it is not clear how much genetic diversity is lost with each disturbance. In the North Carolina Sandhills region, naturally occurring Rhus michauxii appears to be restricted to slightly loamy, but still well- drained, sites which are scattered through longleaf pine/scrub oak/wiregrass woodlands. Loamy soil sites are usually found in slight depressions, swales, or along lower slopes and are quickly recognized by their high diversity of herbs, especially with regard to their high number of legume, composite and grass species (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance range are inferred based on specific habitat needs and low number of populations.

***Dispersal/Migration***

**Motility/Mobility**

Adult: Birds? (USFWS, 1993)

**Dispersal/Migration Narrative**

Adult: Sherman-Broyles et al. (1992) observed that bees visited the flowers of other sumac species and that birds dispersed the fruits (USFWS, 1993).

***Population Information and Trends***

**Population Trends:**

Short-term Trend: Decline of <30% to relatively stable. Long-term Trend: Decline of 30-50% (NatureServe, 2015)

**Number of Populations:**

38 (USFWS, 2021)

**Population Narrative:**

Currently, state natural heritage programs recognize 38 extant natural populations (31 in North Carolina, one in Georgia and six in Virginia), plus four additional introduced populations in Georgia and one in North Carolina. Of these populations, 18 are ranked A or B by their respective natural heritage programs. According to natural heritage program records, the ranks of eight populations (13 occurrences) have improved and 34 populations (51 occurrences) have remained stable. The ranks of 11 populations (20 occurrences) have declined since the 2014 5-Year Review indicating that those occurrences have fewer stems than previously observed, or possibly even disappeared. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Fire suppression (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** This species is threatened by fire suppression and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis (USFWS, 2014).

**Stressor:** Low reproductive capacity (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:** Population degradation
**Narrative:** Low reproductive capacity resulting from the geographic isolation of small single-sex populations is a threat to this species (USFWS 1990) (NatureServe, 2015).

**Stressor:** Logging (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/Loss of plants
**Narrative:** Forested populations are threatened by timber operations. Logging activities can crush plants and 9 or compact the soil where they grow (USFWS, 2014).

**Stressor:** Herbicides (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of plants
**Narrative:** Sites located within utility rights-of way are threatened by herbicide use, mowing during critical growth periods, and ground disturbing activities (USFWS, 2014).

**Stressor:** Development (USFWS, 2014)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Habitat destruction, the result of development or land conversion, also threatens this species (Boyer 1996) (USFWS, 2014).

**Stressor:** Climate change (USFWS, 2014)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The effects of climate change on this species are unknown at this time. However, since this species occurs on dry soils in fire maintained habitat, it seems reasonable to believe that it will not be negatively affected by the predicted increase in droughts and wildfires (USFWS, 2014).

***Recovery***

**Delisting Criteria:**
1. It has been documented that at least 19 self-sustaining populations exist and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 1993).

2. All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 1993).

**Recovery Actions:**
- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats and fire regime; monitor population size and evidence of reproduction (sexual, asexual and seed viability); discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2014).
- Search for additional populations throughout the range of the species (USFWS, 2014).
- Prioritize known sites for protection (USFWS, 2014).
- Protect additional populations through fee simple acquisition, conservation easements, etc. (USFWS, 2014).
- Develop management plans including the use of prescribed fire for all protected populations (USFWS, 2014).
- Develop standardized monitoring protocols, initiate long-term population monitoring and determine the criteria for sustaining populations (USFWS, 2014).
- Reinstate monitoring that was initiated in the early 1990s by Boyer (1996) (USFWS, 2014).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2014).
- Compare, genetically, the populations of questionable taxonomy in VA with those known from NC and GA (especially populations suspected of hybridizing with other species of Rhus) (USFWS, 2014).
- Work with NC Botanical Garden to conserve seeds and germplasm, and develop propagation protocols (USFWS, 2014).
- Consider augmenting populations to increase genetic variation (USFWS, 2014).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed in the 2014 5-Year Review remain important to the conservation and recovery of Rhus michauxii and efforts to accomplish those actions should continue. Since the 2014 5-Year Review, progress has been made on several recommendations for future actions. • Surveys have resulted in the discovery of four new

populations and one new subpopulation of Rhus michauxii. • The Georgia Plant Conservation Alliance has augmented Rhus michauxii populations with plants of the opposite sex and created three new safeguarding populations with male and female plants from different locations. Rhus michauxii has been reintroduced to a previously known site in North Carolina. • Research has been conducted on the pollination ecology of Rhus michauxii. • A genetics study looking at purported hybrids of Rhus michauxii is ongoing at Virginia Tech Conservation Management Institute. • The NCBG, SBG and ABG conserve seeds and maintain live Rhus michauxii plants in their collections for research, reintroductions and education. • The Service has encouraged land managers to develop and implement management plans by providing a template management plan to managers. The Service recommends initiating or continuing the following efforts that will contribute to the recovery of the species: • Consider updating/amending the recovery plan to include quantifiable downlisting criteria. • Revisit known populations that have not been visited in recent years. • Monitor the habitat condition of each site including threats and fire regime. • Monitor population size and evidence of reproduction (sexual, asexual and seed viability). • Discuss conservation options with landowners, where appropriate. • Provide updates about each population visited to natural heritage programs. • Search for additional populations throughout the range of the species. • Prioritize unprotected sites for protection. • Protect additional populations through fee simple acquisition, conservation easements, etc. • Encourage the development of updated management plans, including the use of prescribed fire, for all protected populations. • Develop standardized monitoring protocols, initiate long-term population monitoring and determine the criteria for self-sustaining populations. • Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship). • Identify which populations contain hybrids and determine if they pose harm to the species and/or need special management considerations. • Work with the North Carolina Botanical Garden to conserve seeds and germplasm, and develop propagation and out-planting protocols. • Develop a plan to augment single-sex populations in order to increase genetic variation. (USFWS, 2021)

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# SPECIES ACCOUNT: *Rorippa gambellii* (Gambel's watercress)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A perennial rhizomatous (with creeping underground stems) branched herb that can grow up to 2 meters (6 feet) tall (this height is confirmed by John Chesnut [in litt. 1998] at Oso Flaco Lake). It roots at lower stem nodes, while the upper stem generally remains erect (Figure 2, Photo 2). It blooms from April to July, producing dense inflorescences (flower clusters) with white flowers; the lateral inflorescences may bloom through August. The inflorescences produce 15 to 30 fruits with about 10 to 30 seeds each (Price 1989). The plant has pinnate (feather-shaped) leaves with 7 to 13 uniform leaflets, which are angular and dentate (toothed) in the upper leaves. Small lobes are present at the base of the leaf stalk. Lower flower stalks often have bracts (specialized leaves), and pedicel (flower stalk) junctions with the main stem are flat. These characters separate this taxon from a look-alike, watercress (Rorippa nasturtium-aquaticum), whose three to seven lateral leaflets are entire or wavy-margined and smaller than the terminal leaflet; the leaflets are more lobed than angular in the upper leaves. The smaller flowers of Rorippa nasturtium aquaticum are supported by pedicels without bracts or flat stem junctions. Moreover, the linear and narrower fruits of Rorippa gambelii have more finely reticulate (net-patterned) seeds, which are arranged in one row per chamber, versus two rows per chamber in Rorippa nasturtium-aquaticum. (USFWS, 1998)

**Taxonomy**

Nasturtium gambelii was originally described as Cardamine gambellii in 1876 based on a specimen collected by William Gambel in 1844 in the vicinity of Santa Barbara (Watson 1876). Nasturtium gambelii, the currently recognized name, was originally listed by the Service as endangered under the name Rorippa gambellii (Service 1993). While the circumscription of the species (the limits of the species characters and range) has remained constant since its original description, it has been recognized under several different names (some of the names have similar spelling, but because they were recorded with slightly different names they are listed separately), including Cardamine gambellii (Watson 1876, Abrams 1944), Cardamine gambelii (Jepson 1923; Munz 1959, 1968, 1970, 1974; Hoover 1970; Roberts 1989), Rorippa gambelii (Smith 1976, 1998; Roberts 1998; Service 1998, CNPS 2001), Rorippa gambellii (Al-Shehbaz and Rollins 1988, Rollins 1993, Service 1993, Skinner and Pavlik 1994), Nasturtium gambellii (Al-Shehbaz and Price 1998), and Nasturtium gambelii (Index of California Plant Names 2009). (USFWS, 2011)

**Historical Range**

Historically, Nasturtium gambelii occurred in cismontane regions (on the coastward side of the mountains) of central and southern California, in Orange, San Bernardino, Los Angeles, Santa Barbara, and San Luis Obispo Counties, California. (USFWS, 2011)

**Current Range**

Pure Nasturtium gambelii plants are currently known from one remaining wild population on Vandenberg Air Force Base in Santa Barbara County, California (Keil 1997, CNDDB 2010), and one additional site where plants were introduced in October 2008 on the Refuge in San Luis

Obispo County, California. (USFWS, 2011)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Self-pollinating (NatureServe, 2015)

**Reproduction Narrative**

Adult: Pollinator exclusion experiments have been conducted on this species in the field (Mazer et al. 1994) and demonstrated seed set in bagged specimens. No pollinators were ever seen in 2 seasons of fieldwork. Soil cores taken from the sites where Rorippa are still extant show a viable seed bank in the soil throughout the spring and summer growing season. These seeds germinated under greenhouse conditions. Detailed mortality and longevity data are not yet available for these dormant seeds. The average lifetime fruit and seed production for the Black Lake Canyon population of Rorippa has been estimated at 85.8 fruits and 882 seeds.; Rorippa gambelii requires permanent fresh or brackish wetland areas. It is intolerant of competition and seems to require clearings to survive. Encroaching eucalyptus trees are competing for water and light, and alleopathic effects from the trees may also be harming the Rorippa population. No known diseases or pests attack Rorippa. The very limited distribution of this species and changes in local hydrology are threatening it with extinction.; Predominantly selfing (NatureServe, 2015).

**Habitat Type**

Adult: Wetlands (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits permanent wetlands, fresh or brackish, in marshes or along the borders of lakes and slow-flowing streams or ditches. Soils are acidic sandy peats. Sea level to 450 m elevation. (NatureServe, 2015). High eclogical integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the limited number of populations and the specific haibtat requirements of this species.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal needs further research (USFWS, 1998)

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Number of Populations:**

1 (USFWS, 2022)

**Population Narrative:**

There is currently only one extant, non-hybridized Gambel's watercress population at VSFB, consisting of two separate colonies that occupy a total of 0.024 hectare/0.06 acre (Lum 2021, pers comm). Abundance is unknown due to difficulty of discerning genetically unique individuals above-ground. Currently, we do not have any proposed outplanting projects for the species. (USFWS, 2022) . In 2020, the Service funded a project designed to evaluate the hybridization potential of Gambel's watercress and learn more about its reproductive biology and breeding strategy in an ex situ, greenhouse setting. Santa Barbara Botanic Garden (SBBG) staff made three bulk Gambel's watercress seed collections from the two extant patches at VSFB to start this work in August of 2021. They collected a total of 3,371 seeds from the eastern patch and 1,888 seeds from the western patch. SBBG will bank any seeds not used in direct support of the project (Schneider 2021, pers comm). These banked seeds are of use for additional seed bulking efforts, outplanting recovery projects, and can serve as backup in the event of catastrophic loss of the species. (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Development/Urbanization (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Since the time of listing, there has been a loss and degradation of habitat due to development and urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development and urbanization. Some of this habitat loss has occurred in watersheds that are classified as impaired by the Regional Water Quality Control Board due to excessive amounts of nitrogen and other nutrients (California State Water Resources Control Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998). The excessive growth of some vegetation (e.g., willows, bulrush, Typha (cattails)) causes type conversion of habitat (such as at Black Lake Canyon and Oso Flaco Lake) and a decline in the quantity and quality of habitat suitable for Nasturtium gambelii. Most of the historical populations and their surrounding areas are urbanized and/or indirectly impacted by urbanization, which has further limited this species' ability to colonize adjacent suitable habitat. These conditions also limit sites and opportunities for successful

introductions and reintroductions. (USFWS, 2011).

**Stressor:** Predation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Herbivory has been noted on plants at the introduced site on the Refuge (M.A. Elvin, pers. obs. 2009) and on plants under propagation at University of California, Irvine (UCI) Arboretum (Barry Nerhus, U.C. Irvine, pers. comm. 2006). While this plant may be able to withstand some herbivory, the herbivory may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. The extent of this threat is not known, but the loss of even a few flowers due to herbivory, if it led to an even slight decrease in reproductive success, may have a significant effect on the long-term survival of N. gambelii because there are so few individuals remaining in the wild. Therefore, the relative threat from predation is greater now than was thought to be the case at the time of listing, because there are fewer populations and fewer individuals per population than at the time of listing (USFWS, 2011).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** From the time of listing until recently, existing regulatory mechanisms appear to have done little to ameliorate threats to Nasturtium gambelii, and substantial threats remain; however, recent efforts to improve protections may provide additional benefit to the species in the future. Other Federal and State regulatory mechanisms (e.g., CEQA, California Coastal Act) provide discretionary protections for the species based on current project review and permitting practices (USFWS, 2011).

**Stressor:** Small population size (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Extinction/lack of genetic diversity
**Narrative:** The conservation biology literature commonly notes the vulnerability of taxa known from very few locations or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). The small size of the gene pool of the species (Mazer et al. 2000) may depress reproductive vigor, or increase the likelihood that a single human-caused or natural environmental disturbance (e.g., flood, drought, disease) could cause the extinction of Nasturtium gambelii. Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (having identical pairs of alleles for any given gene), which could result in the expression of disadvantageous traits (Menges 1991). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). The existence of less than five populations and the small number of individuals in these populations places Nasturtium gambelii at extreme risk of extinction due to low levels of genetic diversity (USFWS,

2011).

**Stressor:** Other natural or manmade factors (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/extinction
**Narrative:** Natural catastrophes such as fire, landslide, or prolonged drought could result in the loss of populations (Shaffer 1981), particularly for species with fewer than five populations. An increase in urban development has reduced the range of Nasturtium gambelii considerably. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. Increasing development in the area will likely increase threats from stochastic events. We believe that the existence of one known wild population and the small number of individuals in the population exacerbate the risk of extinction to Nasturtium gambelii from stochastic events.

**Stressor:** Competition with nonnative species (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The effects of competition with nonnative species are most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of Nasturtium gambelii independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of N. gambelii (USFWS, 2011).

**Stressor:** Nutrient loading in watersheds (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Threats identified since the time of listing include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or historically supported Nasturtium gambelii. These nutrient levels can cause excessive growth of vegetation (biostimulation) in some species that may out-compete N. gambelii plants. The excessive growth of other vegetation (both native and nonnative) can have direct effects on N. gambelii individuals. The other plants can outcompete N. gambelii individuals for essential physical and biological elements (i.e., space for growth, food, water, light, minerals). This stress likely effects the survival of some individual plants or occurrences and increases the impact of threats to the species from stochastic events (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Park et al. (1989) projected that of the saltmarshes along the coast of the contiguous United States, 30 percent would be lost with a 1.6-foot (0.5-m) SLR, 46 percent with a 3.3-foot (1-m) SLR, 52 percent with a 6.6-foot (2-m) SLR, and 65 percent with a 9.8-foot (3-m) SLR. While we cannot project directly to California from the estimates of Park et al. (1989) who focused on the

east coast and Gulf coast of the United States, we can anticipate that with a projected SLR of up to almost 6.6 feet (2 m) that much of the coastal saltmarshes in California would be lost by 2100. Beaches, dunes, and coastal areas would be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 (CCC 2001, Heberger et al. 2009). This is estimated to result in erosion and shoreline retreat between 459 and 1 ,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because Nasturtium gambelii historically occurred in coastal dune habitats throughout its range, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks for this species (USFWS, 2011).

**Stressor:** Genetic swamping (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Lack of genetic variability
**Narrative:** The N. gambelii plants at Oso Flaco Lake appear to be genetically compromised and introgressed with the locally abundant nonnative species N. officinale based on morphological and molecular evidence of hybridization (Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2009, 2010; CNPS 2009). The N. gambelii population (at VAFB) has at least two individuals that may be of hybrid origin with N. officinale (Prince 2008a, 2008b). The introgression of N. gambelii plants at Oso Flaco Lake and the potential introgression of two N. gambelii plants at VAFB (Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2009, 2010; CNPS 2009) suggest the species is in danger of extinction.

***Recovery***

**Reclassification Criteria:**
1. When new plants are established so that there are at least 5 populations of at least 500 individuals each (USFWS, 1998)

2. When some of the populations occur in permanently protected habitats within the Black Lake Canyon and the dune lakes area  (USFWS, 1998)

3. When some of the populations are in other areas of suitable habitat with the species' historical range in the United States (USFWS, 1998)

4. When the populations remain viable for at least 5 years. Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation(USFWS, 1998)

**Delisting Criteria:**
1. If threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) controlling competition with nonnative species and hybridization with common watercress, and b) managing water conditions, particularly flow and nutrient loads, that the species depends on. (USFWS, 2019)

2. If populations are established across the species ecological settings (in addition to Black Lake Canyon and the Dune Lakes area in San Luis Obispo County), including suitable site(s) in the Santa Barbara County and Ventura County region (e.g.; the San Antonio Creek drainage on Vandenberg Air Force Base or comparable sites); and coastal wetlands in Los Angeles, Orange, or San Bernardino Counties (USFWS, 2019)

3. If the populations remain viable for at least 10 years. Because this species has narrow microhabitat conditions that it will tolerate, particularly with respect to water flow and nutrient loads, and in light of fluctuations that can occur with climatic conditions and local water availability and nutrient loading, the persistence of populations with these varying conditions over time needs to be confirmed. (USFWS, 2019)

**Recovery Actions:**

- 1. Protect, maintain, and enhance species habitats. The most important immediate objective in the recovery plan for and Rorippa gambelii is the protection of its habitat. - Coordinate among agencies involved in recovery activities. - Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon. - . Establish protection agreements. - Acquire key land parcels and conservation easements. Enhance existing habitat at Black Lake Canyon. - Continue to protect, maintain, and enhance habitat in the Dune Lakes area. - . Communicate species and habitat protection information to all concerned parties. (USFWS, 1998)
- 2. Document and monitor population and habitat characteristics. - Conduct plant surveys. - Protect newly discovered populations. - Monitor all populations and habitats. (USFWS, 1998)
- 3. Conduct research on the ecology and biology of the species. - Identify potential impacts of conducting research. - Determine population characteristics and life history of the species. - valuate species' tolerances. - Investigate the effects of genetic diversity. (USFWS, 1998)
- 4. Augment existing populations. In addition to protecting existing and newly discovered habitats of Rorippa gambelii, monitoring these populations and their habitats, and conducting research on the biology and ecology of the species, attempts should be made to augment existing populations. (USFWS, 1998)
- 5. Establish new populations. Because Rorippa gambelii currently has very restricted distribution in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a catastrophic event could result in the extinction of the species with its current restricted distribution. (USFWS, 1998)
- 6. Evaluate Progress and Update Management and Recovery Guidelines. Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed. (USFWS, 1998)
- Work with the U.S. Air Force at Vandenberg Air Force Base to implement site-specific management activities in the immediate future to avoid and alleviate threats (such as from stochastic events) to prevent the loss of the last, known remaining wild population (USFWS, 2011).

- Work with others to establish new populations in the near future to reduce the risk of extinction to Nasturtium gambelii in each of the two ecological regions of its historical range in California (coastal central California and coastal southern California) (USFWS, 2011).
- Work with others to establish and maintain ex situ stock populations with at least one institution in each of the three ecological regions of its historical ranges (USFWS, 2011).
- Work with the Central Coast Regional Water Quality Control Board to determine nutrient levels in the watersheds which historically supported Nasturtium gambelii in the recent past (particularly Black Lake Canyon and Oso Flaco Lake) to determine what may have led to the loss of N. gambelii form these sites, and work with local landowners and stakeholders to alleviate (and remove) any threats to N. gambelii that are associated with water quality (USFWS, 2011).
- Continue genetic analyses to determine the extent of variation within and between Nasturtium gambelii populations and the magnitude of the threat of gene swamping from N. officinale to help determine an appropriate recovery and reintroduction strategy (USFWS, 2011).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Conduct annual monitoring of both the VSFB and Oso Flaco Lake Gambel's watercress populations. Include counting and reporting the number of above ground vertical stems and global positioning system (GPS) mapping of occupied spatial area, co-occurring and co-dominant vegetation, presence of natives versus nonnative species, percent canopy cover, hydrological conditions, timing of phenology, and presence of potential insect pollinators. Consistent data collection and reporting will allow for meaningful comparisons and analyses of trends. 2. Implement threats management activities at each population, including vegetation management such as trimming and removal, invasive weed abatement, and sediment removal and erosion controls. 3. Document the presence and extent of common watercress within the San Antonio Creek and Osos Flaco Lake watersheds. Improve assessment of morphological traits of pure versus hybrid Gambel's watercress to better facilitate rapid visual assessments of introgression in the field. Conduct control and eradication of common watercress where appropriate. 4. Develop an effective rapid method for sequencing and genotyping to characterize Gambel's watercress genetic population structure and accurately evaluate abundance. 5. Determine if the seed bank harbors additional Gambel's watercress genetic diversity. If so, introduction/reintroduction projects may utilize such grown out plants and potentially restore lost genetic integrity to the species. 6. Determine how vegetative succession and other hydrological changes associated with eutrophication and biostimulation are affecting the species and employ remedial measures to restore occupied habitats to optimal conditions for recovery. 7. Research the species reproductive biology to evaluate and quantify hybridization with common watercress, including self-compatibility, breeding system, seed viability, and morphology of pure and hybrid lineages. Work to better understand the species pollinators, fruiting and seed production, and optimal ecological factors that favor Gambel's watercress growth and population expansion. 8. Conduct genetic studies and other controlled experiments to evaluate the hypothesis that hybrid individuals have reduced viability and that when we remove common watercress, selective forces may act over successive generations to return genotypes back to pure Gambel's watercress forms. (USFWS, 2022)

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# SPECIES ACCOUNT: *Sarracenia rubra ssp. alabamensis* (Alabama canebrake pitcher-plant)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015) 3/10/1989

**Physical Description**

An insectivorous perennial herb with light green, red-veined leaves that form erect, vase-like structures, 1-5 dm tall (in late summer, these are enlarged and turn yellow-green). Flowers are 5-merous, with maroon petals that are constricted medially, to 2.5 cm in width and 3.6 cm in length; pendent, borne singly on an erect, leafless scape to 60 cm in height. Flowering season: late April to early June (NatureServe, 2015).

**Taxonomy**

There is taxonomic uncertainty within the genus Sarracenia as a whole but the Services and others recognize the taxon as a subspecies within the "rubra complex" (i.e., Sarracenia rubra ssp. alabamensis) (USFWS, 2018).

**Historical Range**

The Alabama canebrake pitcher plant is a carnivorous plant that is endemic to central Alabama, with all known populations, extant and extirpated, found in the Fall Line Hills ecoregion (USFWS, 2019). Species historically occurred in Autauga, Chilton, and Elmore Counties, Alabama. In Autauga County one population has since been extirpated (Byrd 2016) and the remaining five now represent three populations, with two populations continuing as distinct populations and three of the former populations now representing three sub-populations comprising one population. No extant populations are known to occur in Elmore County (USFWS, 2018).

**Current Range**

There are currently seven natural, extant populations of Alabama canebrake pitcher plant known (Autauga County – 3; Chilton County – 4) (USFWS, 2018). All are found in the Fall Line Hills ecoregion (see Griffith et al. 2001 for ecoregion description). Furthermore, within this ecoregion, most of the species' populations are known from the Upper Alabama subbasin (8-digit hydrologic unit code: 03150201) while the remaining populations are known from the Lower Coosa subbasin (03150107) (USFWS, 2019).

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: This is a carnivorous plant, although it is unclear what benefit it receives from its carnivory (USFWS, 1992). Studies found that Alabama canebrake pitcher plants captured comparatively more flying insects than crawling insects, likely due to the species' relatively tall stature (USFWS, 2018).

**Reproductive Strategy**

Adult: Vegetatively

**Lifespan**

Adult: Perennial herb, 60+ years (USFWS, 2012)

**Dependency on Other Individuals or Species**

Adult: Likely pollinators for this species are small bumblees (USFWS, 2018).

**Reproduction Narrative**

Adult: Seedling recruitment was reported to be absent from the majority of populations (Brewer and Chesser 2009), further inhibiting recovery efforts, as well as long-term viability and evolutionary potential. Because the species can reproduce vegetatively, seedling recruitment may not be paramount at sites experiencing light to moderate levels of fire exclusion; however, vegetative reproduction may not compensate for mortality or the lack of sexual reproduction at some sites (Brewer and Chesser 2009) (USFWS, 2012). Likely pollinators are small bumblebees (Bombus spp.) which have a flight distance of 1 mile; at distances greater than 1 mile, pollen flow (and consequent gene flow) is restricted by the inability of pollinators to traverse this distance (USFWS, 2018).

**Habitat Type**

Adult: Hillside seepage bogs and in bottomland or streamside vegetation(USFWS, 2012)

**Environmental Specificity**

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Sarracenia rubra ssp. alabamensis inhabits two distinct habitat types that share similar floristic composition. The majority of sites are characterized as hillside seepage bogs, permanently saturated areas that attain their greatest development where an impervious layer of clay lies in close proximity to the ground surface. Precipitation, once reaching this clay zone, becomes restricted and is gradually propelled along a sloping gradient until surfacing further downslope. The other habitat type occurs in association with bottomland or streamside vegetation. Unlike the foregoing habitat, moisture conditions are generally maintained with greater connection to topography and precipitation amounts (USFWS, 2012). All extant populations of S. rubra ssp. alabamensis occur in close association with the following combination of arborescent and herbaceous species (which therefore serve as the best indicators of suitable habitat): Osmunda cinnamomea (cinnamon fern), Rhynchospora chalarocephala (loosehead beak sedge), Dichanthelium scoparium (velvet panicgrass), Xyris torta (twisted yellow-eyed grass), Eriocaulon decangulare (tenangle pipewort), Arundinaria gigantea (giant cane), Cleistes bifaria (small spreading pogonia), Calopogon tuberosus (tuberous grass pink), Platanthera ciliaris (yellow-fringed orchid), Viola primulifolia (white violet), Rhexia nashii (maid Marian), Eryngium integrifolium (blue coyotethistle), Asclepias rubra (red milkweed), Magnolia virginiana (sweetbay magnolia), Solidago rugosa (wrinkle-leaf goldenrod), Eupatorium fistulosum (joe pye weed), Fuirena squarrosa (hairy umbrella-sedge), and Sphagnum spp. Bottomland and streamside populations generally contain a greater proportion of woody species and A. gigantea (U.S. Fish and Wildlife Service 1992, Garrett 2004, Schotz 2006) (USFWS, 2012). It is most vigorous in open bogs and declines when the habitat becomes overgrown with woody vegetation (NatureServe, 2015).

***Dispersal/Migration***

**Dispersal**

Adult: Seed dispersal is poorly understood but studies with similar pitcher plants indicate seed dispersal distances from parent plants at typically a few inches and water or birds may facilitate dispersal over longer distances, but this remains unstudied for Alabama canebrake pitcher plant (USFWS, 2018).

**Dispersal/Migration Narrative**

Adult: Brewer and Chesser (2009) at the University of Mississippi recently completed a study correlating seedling recruitment and population dynamics in relation to site differences. They found that seedling recruitment was greater on sites with higher soil moisture content as opposed to drier sites. This correlation held true even when comparing unmanaged wet sites to managed dry sites (USFWS, 2012).

***Population Information and Trends***

**Population Trends:**

Stable (USFWS, 2018)

**Species Trends:**

Stable (USFWS, 2018)

**Number of Populations:**

8 (USFWS, 2023)

**Population Narrative:**

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. According to anecdotal information furnished by wildflower enthusiasts, some sites historically contained thousands of plants. Was likely stable when fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to the impact such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including Sarracenia rubra ssp. alabamensis, have become critically imperiled (NatureServe, 2015). Short-term trends indicate that species has remained stable, despite the recent loss of one small population and apparent local population declines at some sites which are likely offset by population increases at the largest sites. Currently, there are seven natural, extant populations of this species (3 in Autauga

County and 4 in Chilton County) where a population is considered distinct if separated by at least 1 mile from nearest known neighbors; no new populations have been discovered since 2012. Currently, individual subpopulations range in size from 3 or 4 plants to well over 200 and all populations are privately owned. Only 3 populations are comprised of 100 or more individuals, while 2 populations have fewer than 10 individuals (Byrd 2016, 2017, Yawn 2018). Several attempts to augment and establish populations are known but information on sites is limited and their contribution to recovery is uncertain. Conservation efforts in cooperation with various entities has occurred and 3 populations are permanently protected and managed by TNC but three populations have been extirpated since the species was listed (USFWS, 2018). The species is currently only found in Autauga and Chilton Counties and is considered extirpated in Elmore County, Alabama. Of Alabama canebrake pitcher-plant's 12 known populations, 8 are extant (including one small population consisting entirely of transplanted individuals and their progeny), and 4 are extirpated. While one population was discovered since the 2018 5-year review, another population has since been extirpated. In addition to few extant populations, small population size remains a threat with most (5 of 8) populations having less than 100 plants. Only 3 populations have 100 or more plants and only 1 population has over 1,000 plants. Two populations occur on conservation lands; however, one of these protected populations is also the largest known population (encompassing nearly threequarters of the species' entire known population in the wild). While overall population size has increased since the mid-1990s by over 48%, active recruitment of the species is generally low, with recent observations noting seedlings at only 3 populations, which represent only a small fraction of individuals within each of these populations. Discovery of additional populations and population augmentation have also contributed to recent population increases (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Woody succession (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The inability to regularly burn some sites has reduced habitat suitability by allowing continued encroachment of woody species that increase shade for this shade-intolerant species (USFWS, 2012).

**Stressor:** Fire suppression (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** All populations occur in fire-maintained habitat, requiring an active prescribed burning regimen to sustain species viability and site integrity. As with all pitcher-plants, S. rubra ssp. alabamensis is intolerant of shade, quickly becoming depauperate and unable to reproduce with the encroachment of woody vegetation. Therefore, site integrity and viability of all populations are inherently linked to regular prescribed burning. Efforts by U.S. Fish and Wildlife Service, ALNHP, TNC, and Atlanta Botanical Gardens to adequately maintain specific populations have been hampered by difficulties in obtaining permission to apply prescribed fires at some of the known populations and unfavorable burning condition (USFWS, 2012).

**Stressor:** Gravel mining (USFWS, 2012)

**Exposure:**
**Response:**
**Consequence:** loss of habitat
**Narrative:** Gravel mining in close proximity to another population has adversely altered the hydrology of the site, further hampering recovery efforts (Byrd 2011, Tassin in litt. 2011b) (USFWS, 2012). However, the cooperation and interest in conserving this site by the landowner has allowed land management activities to reduce the impacts of gravel mining induced hydrologic alterations (Byrd 2016, 2017, ANHP 2018, Yawn 2018) (USFWS, 2018).

**Stressor:** Drainage of wetlands/bogs (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** loss of habitat
**Narrative:** Alabama canebrake pitcher plant populations continue to be threatened by development and incompatible land use, such as drainage for agriculture and livestock grazing (USFWS, 2012).

**Stressor:** Habitat modification (USFWS, 2018).
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species continues to be threatened by development, agricultural activities, gravel mining, and livestock management (Schotz 2006, Byrd 2016, 2017, ANHP 2018, Yawn 2018), which can exacerbate threats posed by inadequate habitat management (e.g., fire exclusion) and encroachment of competing vegetation (including non-native invasive species)(USFWS, 2018).

**Stressor:** Hydrologic alterations (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Two populations have historically been subjected to hydrological alterations as a result of beaver (Castor canadensis) activities, one of which was nearly extirpated by flooding. Beaver trapping has occurred at one of these populations to reduce their impact (USFWS, 2018).

**Stressor:** Inadequate habitat management (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Inadequate habitat management threatens the long-term viability of some populations. All populations occur in habitat requiring periodic fire to maintain site ecological integrity and population viability. The lack of prescribed fire or periodic mowing and hand clearing of competing vegetation at some sites allows for unchecked growth of woody species and other fast-growing herbaceous species that can increase shade and competition for resources. Alabama canebrake pitcher plant is intolerant of shade, with individual plants and, ultimately, populations, quickly becoming depauperate and unable to reproduce following woody species encroachment and consequent increased shade. Prescribed fires and other vegetation clearing activities help to maintain Alabama canebrake pitcher plant’s necessary open, sunny habitat. In addition, over the years, ANHP, TNC, and ABG have occasionally had difficulties

obtaining landowner permission to apply prescribed fires at some sites, thus hampering necessary efforts to adequately maintain these sites (Byrd 2016, ANHP 2018). One small population was recently lost, possibly due to incompatible road right-of-way maintenance, such as herbicide application (Byrd 2016). Habitat management is need to promote seedling recruitment. Alabama canebrake pitcher plant continues to be extremely vulnerable due to the small number of populations and small population size at many of these sites (USFWS, 2018).

***Recovery***

**Reclassification Criteria:**

1. At least 10 geographically distinct populations of sufficient size within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. Populations are considered to be geographically distinct when they are separated by at least 1 mile (1.6 kilometer) from their nearest neighbors. (Addresses Factors A, B, E) (USFWS, 2019).

2. These 10 populations are protected by a conservation mechanism that addresses the conservation needs of the Alabama canebrake pitcher plant. (Addresses Factors A, D) (USFWS, 2019).

3. Protected populations are managed to promote open canopies, integrity of native plant communities, and Alabama canebrake pitcher plant growth. (Addresses Factors A, E) (USFWS, 2019).

Recovery Priority Number: 6

**Delisting Criteria:**

In addition to meeting downlisting criteria, the Alabama canebrake pitcher plant will be considered for delisting when the following criteria are met:

4. At least 10 additional geographically distinct populations of sufficient size (as described in Criterion 1) within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. (Addresses Factors A, B, D, E) (USFWS, 2019).

5. The Upper Alabama and Lower Coosa sub-basins within Fall Line Hills ecoregion each support at least three (3) viable populations protected by a conservation mechanism. (Addresses Factors A, E) (USFWS, 2019).

**Recovery Actions:**

- A. Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- B. Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- C. Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- D. Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).

- E. Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way (USFWS, 2012).
- F. Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012). Efforts have expanded to include Auburn University's Donald E. David Arboretum (USFWS, 2018).
- G. Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- H. Update the recovery plan, as appropriate (USFWS, 2012).
- Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).
- Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way. 10 (USFWS, 2012).
- Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- Update the recovery plan, as appropriate (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES Current recovery criteria are presented in the Recovery Plan Amendment (Service 2019) while the Recovery Plan (Service 1992) provides a detailed discussion of necessary recovery actions. During this status review, new and/or targeted potential recovery activities were identified and are included below. These actions are recommended to support and promote recovery of the Alabama canebrake pitcher-plant. Use of a numbered list for these recommendations is for convenient reference only and does not necessarily imply prioritization of any activity over others. Recovery Activities 1. Continue the use of prescribed fire at protected sites and encourage and cooperate with landowners of unprotected sites to conduct prescribed fire as frequently as possible to maintain favorable habitat conditions. 2. Where use of prescribed fire is not feasible, use fire surrogates such as hand clearing and mowing of competing vegetation to maintain favorable habitat conditions. 3. Work with landowners and cooperators to secure adequate protection of privately-owned populations. 4. Work with state, county, and local transportation departments to ensure proper protective measures are implemented for those areas where Alabama canebrake pitcher-plants occur within roadside rights-of-way. 5. Continue to preserve genetic material from all populations through long-term seed storage and live plant collections ex situ (off-site). Monitoring and Research Activities 1. Continue to track population trends and evaluate management needs and efficacy. 2. Expand surveys in the vicinity of known populations and revisit known historical sites regularly to locate and/or relocate populations. 3. Determine the extent that current ex situ collections represent the genetic diversity of in situ populations and expand ex situ collections if necessary (USFWS, 2023).

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# SPECIES ACCOUNT: *Sarracenia rubra ssp. jonesii* (Mountain sweet pitcher-plant)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015) 9/30/1988

**Physical Description**

An insectivorous perennial herb with waxy-green, maroon-veined leaves that form erect, vase-like "pitchers" with ascending "lids." The pitchers are usually about 4.5 dm tall and are often partially filled with a broth of decaying insects. The sweet-smelling flowers are borne singly, each nodding on erect flowering stems that are usually taller than the pitcher. Flower petals are pendulous, maroon on the outside and yellowish, tinged with red on the inner surface. Blooms in spring. (NatureServe, 2015)

**Taxonomy**

Treated as a subspecies of Sarracenia rubra by Kartesz (1994 checklist), but considered a distinct species (S. jonesii) by North Carolina Heritage Program (1993), CITES (2001), and FNA (vol. 8, 2009). (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Endemic to a few mountain bogs and waterslides in southwest North Carolina and northwest South Carolina on both sides of the Blue Ridge divide (U.S. Fish and Wildlife Service 1990). Four populations are in the French Broad River drainage in Henderson and Transylvania Counties, North Carolina, five are in the Saluda River drainage in Greenville County, South Carolina, and one population is in the Enoree River drainage also in Greenville County, South Carolina (U.S. Fish and Wildlife Service 1990). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: Carnivory is the most striking interaction between members of the genus Sarracenia and other species, though the precise benefit to pitcher plants from this highly specialized adaption is not understood. Christensen (1976) found that when insects were fed to Sarracenia flava, there was no consequent increase in calcium, magnesium, or potassium in the plants' leaf tissue. However, nitrogen and phosphorus did increase, indicating that carnivory may be useful in soils low in these elements. Folkerts (1982) suggests that carnivory may be used to obtain micronutrients, such as molybdenum, which are present at very low levels in a low ph environment. Folkerts (1982) also proposes that carnivory may be important at times of nutrient stress since nutrient levels in bogs decrease over the course of the growing season. Another possibility is that the breakdown of prey detritus from decaying pitchers may help fertilize the soil around the plants (Christensen 1976). In addition to carnivory, pitcher plants have intricate relationships with several different animal taxa. Members of the genus Sarracenia are the exclusive food of at least five species of moth (Damman and French 1987), and other insects are known to live inside pitchers (U.S. Fish and Wildlife Service 1990). Some insects may be restricted to S. jonesii (T. Gibson, pers. comm., in U. S. Fish and Wildlife Service 1990).

**Reproductive Strategy**

Adult: Asexual and sexual (NatureServe, 2015)

**Lifespan**

Adult: Perennial herb (USFWS, 1990)

**Breeding Season**

Adult: Flowering occurs from April to June, with fruits ripening in August (U.S. Fish and Wildlife Service 1990) (NatureServe, 2015).

**Reproduction Narrative**

Adult: REPRODUCTION: Reproduction in S. jonesii occurs by seed and by fragmentation of the rhizomes, but the relative importance of sexual versus vegetative reproduction is not known (U.S. Fish and Wildlife Service 1990). Flowering occurs from April to June, with fruits ripening in August (U.S. Fish and Wildlife Service 1990). Pollinators of S. jonesii are not know, but bumblebees are important pollinators of other species of Sarracenia (U.S. Fish and Wildlife Service 1990). Water is the only known means of seed dispersal (U.S. Fish and Wildlife Service 1990). GENETICS: Many populations of S. jonesii are small and have likely been isolated for a long time. Consequently, inbreeding depression may be occurring (U.S. Fish and Wildlife Service 1990).; ASEXUAL; Perfect; Predominantly outcrossing; SEXUAL; Vegetative spread; ABIOTIC; Water; BIOTIC; Insects, other (NatureServe, 2015).

**Habitat Type**

Adult: Bogs (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/Specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: The mountain sweet pitcher plant occurs in two types of habitat, depression bogs and cataract bogs. Most commonly, this species is found in depression bogs with flat to gently sloping topography in valley bottoms not subjected to flooding (Schafale and Weakley 1990; U.S. Fish and Wildlife Service 1990). The soils of these bogs are deep, poorly drained loam/sand/silt, with high organic matter and acidic pH. The soil series is usually Toxaway silt loam or Hatboro loam (U.S. Fish and Wildlife Service 1990). These bogs are palustrine and usually fed by seepages. The moisture level within the bogs ranges from permanently saturated to intermittently dry (Schafale and Weakley 1990). In the cataract bog habitat, the pitcher plants grow in thin strips along the edges of the waterfall, or on soil islands actually on the granite rock face where moisture conditions are appropriate (U.S. Fish and Wildlife Service 1990; S. Benjamin, pers. observ.). Shrub species associated with Sarracenia jonesii populations include Rhus vernix (poison sumac), Aronia arbutifolia (chokeberry), Alnus serrulata (alder), Rhododendron maximum (rhododendron), Rhododendron viscosum (azalea), Viburnum cassinoides (viburnum), Kalmia angustifolia (sheep laurel) and Kalmia latifolia (mountain laurel) (U.S. Fish and Wildlife Service 1990). Associated herb species include several sedges (Carex leptalea, C. muricata, C. folliculata, and C. collinsii), twigrush (Cladium mariscoides), beak rush (Rhynchospora alba), bulrush (Scirpus expansus), and several Sphagnum species (U.S. Fish and Wildlife Service 1990) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively low number of known populations.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: At least some seed dispersal is by water; however, little else is known, including how far seeds can be dispersed by this vector and others and what conditions are optimal for dispersal (USFWS, 1990).

***Population Information and Trends***

**Population Trends:**

Short term trend: Decline of 10-30% (NatureServe, 2015)

**Number of Populations:**

15 (USFWS, 2021)

**Population Narrative:**

The species persists in 12 extant populations across North and South Carolina, in remnant bog habitats that are subject to repeated threats from the continued alteration of the surrounding landscape, particularly the ecological processes (namely hydrologic regimes) which render these wetlands suitable for species such as S. jonesii (USFWS, 2013). NatureServe (2015) notes that there is a short-term population decline of 10-30%. Low resiliency, representation and redundancy are inferred based on the low number of populations and the specific habitat requirements of this species.

***Threats and Stressors***

**Stressor:** Stream channelization (USFWS, 2013)
**Exposure:**

**Response:**
**Consequence:** Loss of habitat
**Narrative:** This, in conjunction with stream channelization efforts throughout the surrounding watershed, continues to work against the processes which create new wetland acreage, which in turn forces those species that are dependent upon these habitats to be confined to whatever remnant acreage that remains (USFWS, 2013).

**Stressor:** Lack of beaver dams (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Beavers were largely eliminated from much of the southern Appalachian landscape by the turn of the last century. Although still active, their effectiveness at creating new wetland habitat is severely hindered by humans who regard beavers as a nuisance species, and repeatedly breach beaver impoundments (USFWS, 2013).

**Stressor:** Wetland draining (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Because many bogs are located in low-lying flat areas favored for agriculture, they often have been the focus of wetland ditching and draining efforts which have left the hydrology of these sites inherently altered. Further compounded by a nearly complete absence of natural disturbance regimes (such as grazing and/or fire) that may have played a role in keeping woody vegetation at low densities, the structure and composition of southern Appalachian wetlands faces a nearly constant and synergistic set of threats (USFWS, 2013).

**Stressor:** Lack of fire (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Periodic fire may have also played an historical role in keeping some mountain bog habitats structurally open, with the higher light levels favored by species such as S. jonesii. Most Sarracenia species occur in fire-prone habitats, and many Sarracenia species decline during periods of prolonged fire suppression. The historical role of fire in mountain bogs is less clear than in coastal plain habitats, but the presence of fire-adapted species such as pitch pine (Pinus rigida) certainly suggests a role for fire in the formation and maintenance of these habitats. However, the extent to which fire suppression may be causing or exacerbating woody vegetation encroachment in bog habitats is presently speculative, at best (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5C

**Delisting Criteria:**
Criterion 1: It has been documented that at least four populations within each drainage (Enoree, French Broad, and Saluda Rivers) are self-sustaining and that necessary management actions

have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 2013).

Criterion 2: …All 12 of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 2013).

**Recovery Actions:**

- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners. Search for additional populations. Determine habitat protection priorities. Evaluate habitat protection alternatives (USFWS, 1990).
- Determine and implement management necessary for long-term reproduction. establishment. maintenance, and vigor. Determine population size and stage-class distribution for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in a suitable habitat within the species' historic range (USFWS, 1990).
- Develop a cultivated source of plants and provide for long-term seed storage (USFWS, 1990).
- Enforce laws protecting the species and/or its habitat (USFWS, 1990).
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Prepare and distribute news releases and informational brochures. Prepare articles for popular and scientific publications (USFWS, 1990).
- Annually assess success of recovery efforts for the species (USFWS, 1990).
- Recovery Task 2.1: Determine population size and stage class distribution for all populations • Map the spatial extent of each population, assess flower abundance and (of lower priority, only if time permits) the abundance of pitchers/clumps. Perform these assessments in a manner that ensures comparability to the baseline maps and other data obtained for these sites in 1991 and 1992 (Rudd and Sutter 1998 and references therein). Assess whether the spatial extent and/or abundance of populations has remained stable, increased or decreased since that time, accounting for any increases due to population augmentation efforts. Record information on environmental parameters that can impact the plant (e.g., light availability and depth to water table) to examine possible correlations with these parameters and the population size and stage class distribution for all populations (USFWS, 2013).
- Recovery Task 2.7: Develop techniques and re-establish populations in suitable habitat within the species' historic range. • Work with the Atlanta Botanical Garden (ABG) to summarize prior reintroduction, augmentation and introduction activities across all populations. Using this information, conduct site visits as needed to obtain current estimates of transplant survivorship for prior augmentation efforts. • Use this information, supplemented by updated data on overall spatial extent (obtained from mapping) and estimates of flower/pitcher abundance, to assess each population for its current potential to be self-sustaining without augmentation. For populations where augmentation is deemed

necessary (this may currently be most populations), establish preliminary population objectives clarifying the minimum desired number of plants at each location, and a strategy and timeline for meeting this objective through augmentation. Work with ABG and landowners to implement actions required to meet this objective at as many sites as possible, and then discontinue additional augmentation while monitoring is undertaken to determine transplant survivorship and population trends at the new (augmented) baseline (USFWS, 2013).

- Recovery Task 3: Develop a cultivated source of plants and provide for long-term seed storage • Review the provenance of material currently held as seeds or otherwise represented in exsitu holdings at botanical gardens (esp. ABG but also the North Carolina Botanical Garden) to ensure that all known extant populations are represented. • Work with ABG to assess the viability of seed collections, and the longevity of seeds held in long-term storage (USFWS, 2013).
- Recovery Task 6: Annually assess success of recovery efforts • The two existing recovery criteria (for de-listing) are largely redundant; revise criteria that are more specific, objective, and measurable. • Establish down-listing criteria (for reclassification from endangered to threatened). • Finalize technical revision to the federal list of threatened and endangered plant species, changing taxonomy from Sarracenia rubra ssp. jonesii to Sarracenia jonesii.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTION The 2013 5-year review included a list of recommendations to improve recovery of the species. These actions, listed below, remain applicable to species recovery. x Map the spatial extent of each population, assess flower abundance and (of lower priority, only if time permits) the abundance of pitchers/clumps. Perform these assessments in a manner that ensures comparability to the baseline maps and other data obtained for these sites in 1991 and 1992 (Rudd and Sutter 1998 and references therein). Assess whether the spatial extent and/or abundance of populations has remained stable, increased or decreased since that time, accounting for any increases due to population augmentation efforts. x Work with the Atlanta Botanical Garden (ABG) to summarize prior reintroduction, augmentation, and introduction activities across all populations. Using this information, conduct site visits as needed to obtain current estimates of transplant survivorship for prior augmentation efforts. x Use this information, supplemented by updated data on overall spatial extent (obtained from mapping) and estimates of flower/pitcher abundance, to assess each population for its current potential for self-sustainability without augmentation. For populations where augmentation is deemed necessary (this may currently be most populations), establish preliminary population objectives clarifying the minimum desired number of plants at each location, and a strategy and timeline for meeting this objective through augmentation. Work with ABG and landowners to implement actions required to meet this objective at as many sites as possible, and then discontinue additional augmentation while monitoring is undertaken to determine transplant survivorship and population trends at the new (augmented) baseline. x Review the provenance of material currently held as seeds or otherwise represented in exsitu holdings at botanical gardens (especially ABG but also the North Carolina Botanical Garden) to ensure that all known extant populations are represented. x Work with ABG to assess the viability of seed collections, and the longevity of seeds held in long-term storage. x The two existing recovery criteria (for de-listing) are largely redundant; devise revised criteria that are more specific, objective, and measurable (in accordance with Service Recovery Planning Guidance). x Devise downlisting criteria (for reclassification from endangered to threatened) similarly in accordance with Service Recovery Planning Guidance. x Finalize technical revision to the federal list of threatened and endangered plant species (previously submitted to the Service Atlanta Regional

Office), changing taxonomy from Sarracenia rubra ssp. jonesii to Sarracenia jonesii. In light of new information, additional future actions are recommended below: x Work with partners and species experts to develop a standardized monitoring protocol that could be used on many different types of mountain sweet pitcher plant sites. x Work with partners and land managers to conduct range-wide monitoring. x Provide support and, if feasible, pool resources for management and monitoring. x Continue to support research efforts investigating species biology, hybridization, and management techniques. x Determine what constitutes a “self-sustaining” population and determine the appropriateness of the criterion for a species dependent on active management. (USFWS, 2021)

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# SPECIES ACCOUNT: *Schoenocrambe barnebyi* (Barneby reed-mustard)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 01/14/1992; Mountain-Prairie Region (Region 6) (USFWS, 2016)

**Physical Description**

Schoenocrambe barnebyi is a perennial herbaceous plant with sparsely leafed stems 22 to 35 cm (9 to 15 inches) tall arising from a woody root crown. The leaves are entire with a smooth margin, 1.5 to 5 cm (0.6 to 3 inches) long and 0.5 to 2.5 cm (0.2 to 1 inch) wide. The leaf blades are alternately arranged on the stem and are attached to the stem by a petiole. The flowers of S. barnebyi have petals that are light purple with prominent darker purple veins and measure about 12 mm (0.4 inch) long and 2.5 mm (0.1 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of, commonly, two to eight flowers at the end of the plant’s leafy stems (Welsh and Atwood 1980, Rollins 1982, Welsh et al. 1987). Flowers (May-June) have pale purple petals, prominently veined with darker purple. (USFWS, 1994; NatureServe, 2015)

**Taxonomy**

Rollins (1982), in reevaluating the cruciferous genera of Schoenocrambe and Thelypodiopsis, moved T. argillacea and T. barnebyi from Thelypodiopsis to Schoenocranibe as S. argillacea and S. barnebyi. Welsh and Chatterley (1985) moved Glaucocarpuni suffrutescens to the genus Schoenocranibe to complete what morphologically appears to be a discrete phylogenetic unit among the Brassicaceae. The genus Schoenocrambe currently includes five known species, two (S. linearifolia and S. linifolia) are abundant wide—ranging species from the dry lower elevations of the interior western Cordilleras. S. Iinearifolia occurs from southern Colorado and northern Arizona southward to western Texas and Durango and Sonora, Mexico. S. linifolia occurs from southeastern British Columbia, Canada, and western Montana southward to eastern Nevada and northern New Mexico. The remaining three, S. argillacea, S. barnebyl, and S. suffrutescens, are rare endemic species from low elevations of the northern and western portions of the Colorado Plateau in the State of Utah (Rollins 1982, Welsh et al. 1987). (USFWS, 1994)

**Current Range**

Endemic to the Canyonlands of south-central Utah, where known from two distinct clusters of occurrences: one in the southern portion of the San Rafael Swell near Muddy Creek in southern Emery County and the other in Capitol Reef National Park in the Fremont River drainage west of Fruita in central Wayne County. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 1994)

**Breeding Season**

Adult: April to May (USFWS, 1994)

**Reproduction Narrative**

Adult: We have little information on the biology and life history of Barneby reed-mustard. Plants reproduce sexually and flower from late April to mid or late May (Welsh and Neese 1984). (USFWS, 1994)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Bare rock/talus/scree, desert (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs at elevations between 1460 and 1985 meters on sparsely vegetated sites (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Mixed desert shrub communities (shadscale, Eriogonum, Ephedra), in sparsely vegetated sites on steep, eroding north to northeast facing slopes (elevations between 1460 and 1985 meters). Grows in xeric, fine-textured red clay soils rich in selenium and gypsum of the Moenkopi Formation, and, rarely, on soils eroded from it that now overlie the Chinle Formation and on the Carmel Formation. Associated species include Abronia fragrans, Amelanchier utahensis, Artemisia dracunculus, Astragalus brandegeei, Atriplex confertifolia, Chrysothamnus nauseosus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Erioneuron pulchellum, Erioneuron pilosum, Hilaria jamesii, Monolepis nuttalliana, Opuntia polyacantha, Phacelia rafaelensis, Sporobolus sp., Stanleya pinnata, and Townsendia incana. (NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Gravity, wind and rain are thought to be the primary dispersal agent of seeds (Welsh and Neese 1984). (USFWS, 1994)

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Number of Populations:**

4 (USFWS, 2021)

**Population Size:**

<3,000 (USFWS, 2021)

**Population Narrative:**

The species has the same number of populations (four) and estimated total population size (less than 3,000 plants) that we reported in our last status review (Table 1; USFWS 2011). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Mining (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary threat to Schoenocrambe barnebyi identified at the time of listing and in the Recovery Plan was habitat loss and degradation associated with future uranium mining on BLM lands (57 FR 1398, January 14, 1992; USFWS 1994). Mining related activities may result in increased surface disturbances, increased foot and vehicle traffic, reduced air quality, vegetation disturbance, and removal of top soil and overburden. Surface disturbances may impact the species by crushing or trampling plants, causing soil erosion and compaction, degrading suitable habitat, losing pollinator populations and habitat, reducing plant vigor and reproductive potential, reducing seed bank quantity and quality, and increasing invasive plant occurrences thereby increasing fire risk (Brock and Green 2003; BLM 2008a). All of the known individuals on BLM land occur in areas that are open to mineral exploration or development (BLM 2008a). Six mining claims occur near the Sy's Butte/Hidden Splendor Mine and mining activities may have extirpated a portion of this population during the 1950s and 1960s (Anderson 1985; USFWS 1994). Mining shafts from this time period are currently being closed (Conrad pers. comm. 2009; Ivory pers. comm. 2009). With the exception of the Lucky Strike Mine, there has been no mining since the 1960s (Conrad pers. comm. 2009; Ivory pers. comm. 2009). Because BLM lands remain open to mineral exploration and development and there are existing mining claims near the Sy's Butte/Hidden Splendor Mine population that may recommence at any time (Conrad pers. comm. 2009), future uranium mining continues to be a threat on BLM lands. The Service considers this threat to be currently low because it has been over 40 years since active mining occurred, and we are not aware of any current mining proposals in this area. (USFWS, 2011)

**Stressor:** Grazing (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Livestock grazing may result in the direct loss or damage to plants and their habitat through trampling, soil compaction, increased soil erosion, invasion of noxious weeds, and disturbance to pollinators (Kauffman et al. 1983; Fleischner 1994; Kearns et al. 1998; DiTomaso 2000). Sheep and cattle grazing were identified as possible historic threats to populations of Schoenocrambe barnebyi (57 FR 1398, January 14, 1992; USFWS 1994). At the time of listing, the intensity of grazing at known S. barnebyi populations was not expected to significantly impact the species. Grazing intensity has not increased since we finalized the Recovery Plan (BLM 2009). However, the Service does not have any monitoring data that evaluates the effects of grazing on S. barnebyi populations. (USFWS, 2011)

**Stressor:** Off-highway vehicle use (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Services did not identify off-highway vehicle (OHV) activities as threats to Schoenocrambe barnebyi when we listed the species in 1992, nor in the Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). The OHV use may result in the direct loss or damage to plants and their habitat through soil compaction, increased soil erosion, reduced air quality, invasion of noxious weeds, and disturbance to pollinators and their habitat (Eckert et al. 1979; Lovich and Bainbridge 1999; Ouren et al. 2007; Wilson et al. 2009). The use of OHVs in Utah has exploded in popularity over the past several decades (Burr et al. 2008). From 1998-2006, the number of registered OHVs in Utah has increased by 233% (Burr et al. 2008). The known Schoenocrambe barnebyi population on BLM lands (Sy's Butte/Hidden Splendor Mine) occurs in an area that is open to OHV traffic along designated routes only (BLM 2008a). Although illegal OHV use occurs within the vicinity (BLM 2011), to date, no direct or indirect impacts to the population or individual plants have been documented (Ivory 2009). Due to the remoteness of the population and the steepness of the terrain, the Service expects the overall scope of the threat to be low. (USFWS, 2011)

**Stressor:** Erosion (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Erosion was not considered a threat at the time of listing or in the recovery plan (57 FR 1398, January 14, 1992; USFWS 1994). However, natural erosion of Schoenocrambe barnebyi habitat was listed as a potential threat in a 1992 survey report for the BLM (Ecosphere 1992). Schoenocrambe barnebyi grows in very steep habitats with sparse vegetation. Plants may be uprooted, damaged or destroyed by gullying, slumping or rockslides. Under natural circumstances, the Service presumes the species has adapted to living on a highly erodible substrate. However, erosion may increase as climate changes. Climate change will likely increase heavy precipitation events which can increase soil erosion (Nearing et al. 2004; IPCC 2007; see section 2.3.2.5 below).In addition, erosion may be accelerated through surface disturbing activities. As previously described, OHV use and grazing occur in the habitat of Schoenocrambe barnebyi on BLM lands. Although the Service believes the overall threat level of these activities to be currently low, the Service does not have monitoring data to adequately evaluate the effects, including erosion, of these uses to the plants. (USFWS, 2011)

**Stressor:** Trampling (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** At the time of listing and in our Recovery Plan, we identified trampling by Capitol Reef visitors as the primary impact on the Schoenocrambe barnebyi population at Sulphur Creek (57 FR 1398, January 14, 1992; USFWS 1994). However, trampling from hiking activities was later evaluated and determined to be unlikely (Clark 1997). Visitors tend to remain along the trail in the creek bottom, away from the plants and the habitat due to the steepness of the terrain. An historic livestock trail through the population is no longer in use but is occasionally used by deer (Clark pers. comm. 2009a). All other sites within Capitol Reef were evaluated for potential

impacts caused by hiking trails but none were documented (Clark 2005b). For these reasons, we no longer consider trampling a threat. (USFWS, 2011)

**Stressor:** Invasive species and fire (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive species and fire were not considered threats at the time of listing or in the species' Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). However, the spread of nonnative invasive species is considered the second largest threat to imperiled plants in the United States (Wilcove et al. 1998). Invasive plants—specifically exotic annuals—negatively affect native vegetation, including rare plants. One of the most substantial effects is the change in vegetation fuel properties that, in turn, alter fire frequency, intensity, extent, type, and seasonality (Menakis et al. 2003; Brooks et al. 2004; McKenzie et al. 2004). Shortened fire return intervals make it difficult for native plants to reestablish or compete with invasive plants (D'Antonio and Vitousek 1992). Mining, grazing, and unauthorized OHV use are activities that disturb soil surfaces within Schoenocrambe barnebyi habitat on BLM lands. In general, B. tectorum is known to invade areas in response to these types of surface disturbing activities (Hobbs 1989; Rejmanek 1989; Hobbs and Huenneke 1992; Evans et al. 2001). These types of surface disturbing activities do not occur on the populations in Capitol Reef. Currently wildland fires are considered unlikely to occur in S. barnebyi's habitat due to the sparseness of vegetation associated with the species (Borthwick pers. comm. 2009c; Ivory pers. comm. 2009). (USFWS, 2011)

**Stressor:** Herbivory (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Schoenocrambe barnebyi appears to be highly palatable to deer (Clark 2005b). The Service expects browsing to be localized and only affect a small portion of the populations. However, we do not have any information that browsing is occurring at a level that negatively impacts the species as a whole (Clark 2005b; Ivory 2009). For these reasons, this factor has the potential to affect the species. (USFWS, 2011)

**Stressor:** Small populations (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The original listing decision cited the limited distribution and low population numbers as a factor affecting the species (57 FR 1398, January 14, 1992). The species' rarity and limited distribution make it highly vulnerable to localized stochastic extinction events. While more sites have been found since the species was listed, it remains narrowly distributed in few populations and may be in decline (Clark 1997; Anderton 2002). Half of the sites have fewer than 100 plants (Clark 2005b; see Table 2). Although small population size is an intrinsic vulnerability of the species, some sites may hold so few plants that they are not demographically stable in the medium to long term and some may be lost as a result of natural variation in population numbers in the short term. Population genetics studies have not been undertaken for Schoenocrambe barnebyi, but despite the overall lack of information on the population ecology of the species,

the Service does know that small populations are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Only the larger sites of S. barnebyi may have sufficient genetic variability to provide for long-term adaptation to natural or manmade changes in their environment. Small population size in and of itself is not considered a threat; however, it may increase the species' vulnerability if other threats discussed in this analysis are impacting the species. Even a small localized disturbance such as mining, OHV-related activities, or fire could result in the extirpation of a site. The Service determined the threat of climate change (see discussion below) has an overall threat level of moderate. Therefore, the Service considers the overall threat level for small population size to be moderate. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Species with limited ranges and restricted habitat requirements also are more vulnerable to the effects of global climate change (IPCC 2002; Jump and Penuelas 2005; Machinski et al. 2006; Krause 2010). Climate change was not discussed in the original rule to list the species or in the Recovery Plan. Over the past 50 years, the frequency of cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). Changes in the global climate system during the 21st century are hypothesized to be larger than those observed during the 20th century (IPCC 2007). For the next two decades, a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007). Afterward, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase of 0.6 to 4.0°C (1.1 to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). Effects related to climate change, such as persistent or prolonged drought conditions, increased invasions of exotic species and pests, and increased heavy rainfall events, may affect the long-term persistence of S. barnebyi. Climate change could potentially reduce the overall abundance of Schoenocrambe barnebyi. However, a large degree of uncertainty exists regarding the extent of such effects. For these reasons, this factor has the potential to affect the species. Further studies should be conducted to monitor and minimize the effects of this potential threat. (USFWS, 2011)

**Stressor:** Lack of scientific knowledge/monitoring (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The lack of scientific knowledge of Schoenocrambe barnebyi may cause the species to be managed below optimal levels. While not a threat in and of itself, this factor affects our ability to manage and recover the species. We lack scientific knowledge and monitoring data throughout the range of the species. We know little about S. barnebyi--its pollinators, range, habitat, and population trends. For example, we do not know why the original population estimate for BLM population was 2,000 individuals but surveys since have counted less than 200 plants. We do not know whether this represents a reduction in plant numbers or is an artifact of survey effort, making it difficult to analyze overall threat levels for the species. Because of this lack of scientific knowledge, opportunities for better management of the species could

potentially be missed. Based on our current limited understanding of the species, we consider the overall threat levels for threats discussed in sections 2.3.2.1, 2.3.2.4, and 2.3.2.5 are all low. We could potentially move the species toward downlisting, recovery, and eventual delisting if we could better quantify the degree of threat the species faces and work toward alleviating those threats. However, the only site that has longer, albeit irregular, monitoring data shows the plant may be in decline, potentially negatively impacted by drought (Clark 1997; Anderton 2002), and potentially able to recover (Clark pers. comm. 2009b). The lack of trend data following the drought makes it difficult to determine to what degree drought may be a threat to the species. (USFWS, 2011)

***Recovery***

**Reclassification Criteria:**
1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 2011)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 2011)

Recovery Priority Number: 17

**Delisting Criteria:**
1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 2011)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 2011)

**Recovery Actions:**
- Inventory suitable habitat for S. argillacea, S. barnebyl, and S. suffrutescens and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 2011)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 2011)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for each species. (USFWS, 2011)
- Control activities which affect the habitat of S. argillacea, S. barnebyi, and S. suffrutescens through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 2011)
- The BLM and Capitol Reef should establish long-term trend monitoring to provide base line demographic data for the species. In addition to collecting baseline demographic data, BLM and Capitol Reef should collect data on the species’ response to habitat conditions including how the factors considered in this 5-year review are affecting the species. (USFWS, 2011)

- Determine pollinators or pollination mechanisms including the identification of pollinators, pollinator availability, and their habitat requirements. (USFWS, 2011)
- Asses seedbank viability, including seed viability and dispersal mechanisms and determining germination requirements. (USFWS, 2011)
- Analyze population genetics to assess potential impacts from inbreeding depression. (USFWS, 2011)
- Determine the species' vulnerability to prolonged drought and the potential impacts of climate change. (USFWS, 2011)
- Determine the species response to invading nonnative species and its response to increased fire frequencies. (USFWS, 2011)
- Determine habitat requirements, including soils, aspects, and climatic variables. (USFWS, 2011)
- Determine the effects livestock grazing has on the species and its habitat. (USFWS, 2011)
- Determine the effects OHV use has on the species and its habitat. (USFWS, 2011)
- Determine the effects mining has on the species and its habitat. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***

- Recommended future actions: Based on recent discussions with other Federal agencies and partners, we recommend the following future actions: (1) avoid and minimize impacts from mineral exploration and development and other activities in occupied habitat; (2) develop a habitat suitability model for the species; (3) survey potential suitable habitat for occupancy; (3) establish demographic and population trend monitoring within all populations; (4) provide habitat protections through regulatory mechanisms or conservation plans; (5) evaluate reproductive success and pollinator limitations; (6) collect seeds and implement propagation efforts in horticulture facilities; (7) establish new populations; and (8) develop public awareness and appreciation for the species' conservation (USFWS 2020). (USFWS, 2021)

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USFWS. 2021. 5- Year Review Short Form Species Reviewed: Barneby reed-mustard (Schoenocrambe barnebyi). 7 pp.

# SPECIES ACCOUNT: *Schoenocrambe suffrutescens* (Shrubby reed-mustard)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/06/1987; Mountain-Prairie Region (Region 6) (USFWS, 2016)

**Physical Description**

Shrubby reed-mustard is a perennial herb in the mustard family, with clumped stems 10 to 25 cm (4 to 12 inches) tall arising from a branching woody root crown. The leaves are entire with a smooth margin, 1.0 to 2.5 cm (0.4 to 1 inch) long and 0.3 to 1.0 cm (0.12 to 0.4 inch) wide. The leaf blades are alternately arranged on the stem and are subsessile or attached to the stem by a short petiole. The flowers of Shrubby reed-mustard have petals that are light yellow or greenish yellow and spatulately shaped measuring about 10 mm (0.4 inch) long and 3 mm (0.12 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of, commonly, 5 to 20 flowers at the end of the plant's leafy stems. This herb produces yellow flowers May through June. (USFWS, 1994; NatureServe, 2015)

**Taxonomy**

The species was first discovered in 1935 by Edward Graham, described by Reed Rollins as Thelypodium suffrutescens (Graham 1937), and, in 1938, renamed Glaucocarpum suffrutescens (Rollins 1938; 52 FR 37416; October 6, 1987). The species was listed under the latter name (52 FR 37416; October 6, 1987). Since then, its genus was changed to Schoenocrambe (57 FR 1398; January 14, 1992), Glaucocarpum (Al-Shehbaz 2005), and most recently Hesperidanthus (AlShehbaz 2010). This last taxonomic change is currently accepted in the Flora of North America and the integrated taxonomic information system (ITIS) (Al-Shehbaz 2010; ITIS 2017). However, The Service will still use Schoenocrambe suffrutescens until a formal change in the Federal Register is completed. (USFWS, 2019)

**Current Range**

The species is endemic to the Uinta Basin region in northeastern Utah, and found exclusively within the Lower Green-Desolation Canyon and Willow Creek watersheds. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 1994)

**Dependency on Other Individuals or Species**

Adult: The following native bee species may be Schoenocrambe suffrutescens pollinators: Dialictus perdifficilis, D. sedi, Evylaeus pulveris, Andrena walleye, A. prunorum and Halictus rubicundus (USFWS 1994; Tepedino 2000; Lewis 2010). (USFWS, 2010)

**Breeding Season**

Adult: April to May (USFWS, 2010)

**Other Reproductive Information**

Adult: Shrubby reed-mustard could be pollinator limited if adequate and appropriate insect pollinators are not available (Lewis and Schupp 2014). Seed set is significantly lower in individuals that self-pollinate compared to individuals that are fertilized by cross-pollination (pollen from another plant; Lewis and Schupp 2014). These results also indicate that cross-pollination is critical for maximizing reproduction of the species. A related study of road dust impacts to shrubby reed-mustard found that increases in dust deposition reduced reproduction in the species by significantly decreasing the numbers of mature seeds produced, and showed trends of decreased seed numbers and weight (Lewis 2017). Mean stomatal conductance also significantly decreased with increasing dust presence on leaves, which may impact the overall health and reproductive capacity of the species (Lewis 2017). (USFWS 2019)

**Reproduction Narrative**

Adult: Reproduction is sexual (USFWS 1994), and the species is capable of self-pollination (Tepedino 2000). Flowering for this species occurs in April to May and fruiting occurs May to June. The following native bee species may be Schoenocrambe suffrutescens pollinators: Dialictus perdifficilis, D. sedi, Evylaeus pulveris, Andrena walleye, A. prunorum and Halictus rubicundus (USFWS 1994; Tepedino 2000; Lewis 2010). (USFWS, 2010)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Desert, forest/woodland, woodland - conifer (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs at elevations between 1555 and 1981 meters. (NatureServe, 2015)

**Environmental Specificity**

Adult: Broad (inferred from NatureServe, 2015)

**Dependency on Other Individuals or Species for Habitat**

Adult: Commonly on level to moderately sloping ground surfaces. Soils are dry, shallow, and fine-textured, and are usually overlain by shale fragments. (NatureServe, 2015)

**Habitat Narrative**

Adult: Mixed desert shrub communities and, at some locations, in pinyon -juniper and desert shrub, on semi-barren, white-shale layers of the Evacuation Creek Member of the Green River Formation. Commonly on level to moderately sloping ground surfaces. Soils are dry, shallow, and fine-textured, and are usually overlain by shale fragments. 1555-1981 m elevation. (NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends***

**Population Trends:**

Decline (NatureServe, 2015)

**Species Trends:**

Decline (NatureServe, 2015)

**Number of Populations:**

7 (USFWS, 2019)

**Population Size:**

3,161 (USFWS, 2019)

**Additional Population-level Information:**

Range-wide population trend monitoring plots were established by the BLM in 2017. Preliminary findings suggest that open interspaces are important habitat components for the species (BLM 2017). Species monitoring provided a laseline density of 1.9 shrubby reedmustard plants per one-meter squared for monitoring plots; however, subsequent consecutive surveys are needed to refine our understanding of species density (BLM 2017). It is too early to determine demographic and population trends from this monitoring effort. (USFWS, 2019)

**Population Narrative:**

In 2019, the Service estimated shrubby reed-mustard was limited to 3,161 individuals within three geographic areas and seven populations. The range of the Bad Land Cliffs population has been extended from the 2010 estimate after the discovery of 232 new individuals in an area that was previously unsurveyed (BLM 2017). (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Oil and gas development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Oil and gas resource development operations pose a significant threat to Schoenocrambe suffrutescens populations and habitat (USFWS 1990; 1994). All known populations of S. suffrutescens that occur on Federal lands are leased for oil and gas development (USFWS 1994). In addition, an ongoing natural gas project (currently in the first phase of development) overlaps the entire range of three of the known seven S. suffrutescens populations. These populations account for over 40 percent of the species' known suitable habitat and over 80 percent of all known individuals (USFWS 2008a). Development continues in unoccupied suitable habitat, thereby limiting potential expansion and recovery of the species. Furthermore, development continues to occur in habitats immediately adjacent to occupied habitats. While steps have been taken to minimize these indirect effects, it is unknown if this adjacent development is adversely impacting the viability of S. suffrutescens populations. These

indirect effects, and the protections currently provided, are discussed below. (USFWS, 2010)

**Stressor:** Habitat fragmentation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Schoenocrambe suffrutescens exists in small, low-density populations that might be prone to negative effects from habitat fragmentation. For example, small plant populations fluctuate more widely over time and the smaller the remnant, the more susceptible the population is to extinction (Soulé et al. 1992; Forman and Alexander 1998; Menges 2002; Lienert 2004). Small plant populations can lose genetic variation and their population viability decreases (Ellstrand and Elam 1993; Lienert 2004; Kolb 2008). Fruit set, germination rate, offspring survival, and total numbers of flowers per plant are higher in larger populations than in small populations (Paschke et al. 2002). Similarly, the number of capsules per plant and the number of seedlings per plant are positively correlated with population size (Schmidt and Jensen 2000). Roads associated with energy exploration and development cause a high level of habitat fragmentation. Increased oil and gas developments result in more roads developed in and near S. suffrutescens habitat. Ecological effects of roads to plants can extend more than 328 feet (100 meters) from the road (Angold 1997; Forman 2000; Forman and Deblinger 2000). Disturbance can occur directly from construction or indirectly from road dust, discussed further below (Farmer 1993; Angold 1997; Trombulak and Frissel 2000). There is a strong correlation between vegetation composition and health with distance from a road, although it may take decades for the full effects of road development to be realized (Auerbach et al. 1997; Myers-Smith et al. 2006). (USFWS, 2010)

**Stressor:** Road dust (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Schoenocrambe suffrutescens may be impacted by the indirect effects of road dust associated with oil and gas development. Road traffic mobilizes and spreads dust (Farmer 1993; Trombulak and Frissell 2000), and for every vehicle traveling 1 mile (1.6 kilometers) of unpaved roadway once a day, every day for a year, approximately 2.5 tons of dust are deposited along a 1,000-foot (~300-meter) corridor centered on the road (Sanders pers. comm. 2008). Dust deposition tends to be highest near the road and decreases with increasing distance from the road (Spatt and Miller 1981; Everett 1980; Walker and Everett 1987; Santelmann and Gorham 1988; Myers-Smith et al. 2006). For example, in one study 97 percent of dust was deposited within 410 feet (125 meters) of the road (Walker and Everett 1987). The distance from a road at which dust can affect vegetation varies (see McCrea 1984; Myers-Smith et al. 2006), but negative impacts can occur up to 984 feet (300 meters) away from the road (Everett 1980). Dust negatively affects photosynthesis, respiration, transpiration, water use efficiency, leaf conductance, growth rate, plant vigor, gas exchange, and allows the penetration of phytotoxic gaseous pollutants (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Sharifi 1997; Trombulak and Frissell 2000; Hobbs 2001). Dust comprised of finer particulates was shown to cause more improper functioning of the stomata than larger particles (Ricks and Williams 1974; Eller and Brunner 1975; Eveling and Bataille 1984; Rawson and Clarke 1988; Hirano et al. 1995). Clogged stomata result in increased water loss in two ways: due to an increased transpiration rate because of increased temperatures and due to clogged stomata that are

unable to close at night (Hirano et al. 1995). Other dust effects include inhibiting sunlight from reaching the surfaces of dusted plants (Sharifi et al. 1997). Additionally, a decrease in infra-red light reflectance can result in dusted leaves with a 4 to 5°F (2 to 3°C) higher temperature (Sharifi et al. 1997) compared to undusted leaves (Hirano et al. 1995). Soils near roads can have significantly lower nutrient levels, altered organic horizon depth, higher bulk density, and lower moisture (Auerbach et al. 1997). Furthermore, soil characteristics and plant community composition can remain significantly different up to 28 years after road development (Myers-Smith et al. 2006). We do not know if dust negatively affects plant pollinators. (USFWS, 2010)

**Stressor:** Plant-pollinator interactions (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Many of the negative effects of habitat fragmentation to plants are due to effects on plant-pollinator interactions (Debinski and Holt 2000; Moody-Weis and Heywood 2001; Aizen et al. 2002; Gathmann and Tscharntke 2002; Lennartsson 2002; Kolb 2008). Fragmented plant populations appear to be less attractive to insect pollinators, which spend more time in larger, unfragmented plant habitats (Aizen et al. 2002; Lennartsson 2002; Kolb 2008; Goverde et al. 2002). Furthermore, insect pollinator diversity increases in larger populations (Mustajarvi et al. 2001) and decreases in isolated habitats with smaller plant population sizes (Steffan-Dewenter and Tscharntke 1999). Lower pollinator visitation rates are associated with lower seed sets and reproductive success in fragmented sites compared to intact sites (Jennersten 1988).Bumblebees were observed visiting more flowers on fewer flower stalks in sparser plant populations (Mustajarvi et al. 2001; Goverde et al. 2002). This led to increased self-pollination or near-neighbor pollination contributing to inbreeding (Goverde et al. 2002; Lennartsson 2002). Inbred plants produce fewer flowers and seeds, have smaller plant height and smaller leaf-size, and reduced reproductive success (Steffan-Dewenter and Tscharntke 1999; Lienert 2004; Kolb 2008). Overall, we believe energy related development can cause serious impacts to Schoenocrambe suffrutescens through habitat fragmentation, increased road dust, and disruption of plant-pollinator interactions. Current 300 feet (91 meters) buffers are likely adequate to minimize impacts to the species. Nevertheless, in 2009, the Service initiated studies to quantify the effects of continued energy development related to these factors. (USFWS, 2010)

**Stressor:** Building stone mining (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Schoenocrambe suffrutescens habitat is associated with commercially valuable building stone. Building stone mining can directly disturb individual plants and their habitat, with other effects similar to oil and gas development, including habitat fragmentation, increased dust, and pollinator disturbance. Building stone mining was a significant historical threat to the species. Previous commercial stone excavation caused the extirpation of a portion of the species' population in the vicinity of Big and Little Pack Mountains (USFWS 1994). Today, this factor is only a substantive issue on private land. Although approximately 57 percent of mapped Schoenocrambe suffrutescens populations on BLM lands are open to leasing (BLM GIS data, September 2009), building stone mining does not currently occur in occupied habitat on BLM land (Hansen pers. comm. 2009). On private lands, building stone is currently mined in Schoenocrambe suffrutescens occupied habitat. At one site, seven individual plants and

occupied habitat were destroyed (Brunson 2010). We do not know how widespread this impact is across S. suffrutescens habitat on private lands. With so few individuals of this species, we believe that the loss of any individuals could significantly impact the species. Therefore, based on recently documented disturbance on private lands, the Service believes that building stone mining remains a threat to this species. (USFWS, 2010)

**Stressor:** Small populations (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** When Schoenocrambe suffrutescens was listed, it was known to occur in only nine populations with fewer than 3,000 individuals total, including three populations of fewer than 30 plants each. Recent estimates do not indicate significant changes. Small populations and species with limited distributions are vulnerable to relatively minor environmental disturbances (Given 1994). Small populations are also at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Lower genetic diversity may, in turn, lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Barrett and Kohn 1991; Newman and Pilson 1997). Species with limited climatic ranges and restricted habitat requirements are typically the most vulnerable to extinction (Intergovernmental Panel on Climate Change [IPCC] 2002; Machinski et al. 2006). The risk of extinction is expected to increase for species with low population numbers (IPCC 2002; Jump and Penuelas 2005). The Service lacks information on the population genetics of Schoenocrambe suffrutescens. Recent observations indicate this species produces more seed when it is outcrossed (Lewis 2010). Therefore, the fewer plants are located at a site, the less chance for cross-fertilization. Because population numbers are very low for this species, we consider small population size a threat to S. suffrutescens, but without further research or information, the Service cannot predict the magnitude of this threat. (USFWS, 2010)

**Stressor:** Invasive species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Exotic species are common along highways because seeds are carried and deposited along roads by vehicles, and spread via vehicle-caused air turbulence (Forman and Alexander 1998). Roads promote the spread of invasive species by altering soil characteristics, stressing native vegetation, and providing easier movement by wild or human vectors (Trombulak and Frissell 2000). Spread of invasive species via roads coupled with increased road dust can exacerbate the impact on native species: an increase in fine dust particles can increase nonnative, exotic plant species (Reynolds et al. 2001). Invasive, exotic plant species can contribute to the extinction of native plants (Soulé et al. 1992). Cheatgrass (Bromus tectorum) was documented in Schoenocrambe argillacea habitat (Glisson 2005), in the vicinity of the Big Pack Mountain S. suffrutescens population. Cheatgrass can out-compete native species for soil nutrients and water (Melgoza et al. 1990; Aguirre and Johnson 1991; Pyke and Novak 1994). If it establishes in sufficient density in native plant communities, cheatgrass increases flammability, leading to shortened fire return intervals that make it difficult for native plants to re-establish (D'antonio and Vitousek 1992). Halogeton (Halogeton glomeratus) has been documented growing in S. suffrutescens occupied habitat (Brunson 2009; Buys and Associates 2009, Lewis

2010). Halogeton quickly infests areas that are either left barren from fire or disturbed from mechanical or land management means (Pavek 1992). Halogeton tends to be a poor competitor, but it can accumulate sodium in the soil and alter soil microbiota to the disadvantage of native plants (Kitchen and Jorgensen 2001; Kitchen and Carlson 2008). Although invasive species are present in Schoenocrambe suffrutescens habitat, they have not been noted at high levels. Their distribution is likely to increase over time as invasive annuals increase biomass and seed production at elevated levels of carbon dioxide (Mayeux et al. 1994; Smith et al. 2000; Ziska et al. 2005). Regardless, we do not consider invasive species a threat to S. suffrutescens now or for the foreseeable future. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is likely to affect long-term survival or distribution of native species. In the southwestern United States, including Utah and Schoenocrambe suffrutescens habitat, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960-1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the Southwest (Karl et al. 2009). Hot extremes, heat waves, and heavy precipitation will increase in frequency, with the Southwest experiencing the greatest temperature increase in the continental United States (IPCC 2007). We do not know how changes in precipitation will affect Schoenocrambe suffrutescens. However, we do know that increased drought can be detrimental to many drought-tolerant species. Drought conditions led to a noticeable decline in survival, vigor and reproductive output of rare plants in the southwest during the drought years of 2001-2004 (Roth 2008a, 2008b; Clark and Clark 2007; Hughes 2005; Anderton 2002; Van Buren and Harper 2002, 2003). On the other hand, there is some indication that high-stress areas may contain plants that are adapted to that stressor, and drought-adapted species may experience lower mortality during severe droughts (Gitlin et al. 2006). Effects related to climate change, such as persistent or prolonged drought conditions, may affect the long-term persistence of Schoenocrambe suffrutescens, but without further research or information, it is difficult to predict how. (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 1994)

Recovery Priority Number: 5C

**Delisting Criteria:**
1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at

or above minimum viable population levels. (USFWS, 1994)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 1994)

**Recovery Actions:**

- Inventory suitable habitat for S. argillacea, S. barnebyl, and S. suffrutescens and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 2011)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 2011)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for each species. (USFWS, 2011)
- Control activities which affect the habitat of S. argillacea, S. barnebyi, and S. suffrutescens through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 2011)
- We recommend conducting range-wide, comprehensive surveys for Schoenocrambe suffrutescens within the next year, especially in the Gray Knolls area on tribal land. These data should be used to define and delineate populations, and to help revise the Recovery Plan. (USFWS, 2010)
- Monitoring plots were established for testing plant response to disturbance, and basic demographic data are being collected. We recommend continuing to collect data from at least a portion of these plots indefinitely, even past the need for the disturbance study, to be able to answer basic demographic questions and to monitor reproduction. (USFWS, 2010)
- The previous geological nomenclature that was commonly used to identify potential Schoenocrambe suffrutescens habitat was discarded (Weiss 1990), thus complicating an already difficult search for this species. The Service needs to accurately characterize parent material, soil, and landscape characteristics for S. suffrutescens. This research would allow us to more accurately identify unoccupied but potentially important habitat, areas for focused surveys and reintroduction, and areas where oil and gas development are unlikely to harm the species. (USFWS, 2010)
- Schoenocrambe suffrutescens should be reintroduced to new areas of suitable but unoccupied habitat near existing populations. (USFWS, 2010)
- Basic biological and ecological information should be obtained for this species, including pollination mechanisms and pollinators. This research began in 2010. (USFWS, 2010)
- Studies to quantify the effects of dust, invasive species, and disturbance from continued energy development were initiated in 2009. These studies should be continued until the Service has enough data to draw conclusions. (USFWS, 2010)
- The Service should consider collecting seeds to include this species in the Center for Plant Conservation collection. Seeds should also be tested for viability and longevity. (USFWS, 2010)
- Nearly 40 percent of the mapped Schoenocrambe suffrutescens populations occur on non-Federal lands. We should continue to work with the Uintah and Ouray Indian Reservation, SITLA, and private landowners to survey and conserve S. suffrutescens habitat and increase

outreach efforts. (USFWS, 2010)
- On Federal lands, the Service should continue to avoid development in Schoenocrambe suffrutescens populations and suitable, unoccupied habitat as much as possible, unless research becomes available to indicate that S. suffrutescens is unaffected by development. The Service should ensure that developers follow established conservation measures when disturbance occurs and that habitat fragmentation is reduced as much as possible. (USFWS, 2010)
- Using research collected on soil characteristics and response to disturbance, the Service should identify and establish core conservation areas in minimally-disturbed habitat (both occupied and unoccupied) for long-term protection of S. suffrutescens. (USFWS, 2010)
- Once the Service has new survey data and research data available, the Service recommends revising the Recovery Plan to explicitly address the relevant listing factors. Time and cost required to meet the criteria and recover the species should be included in the Recovery Plan. (USFWS, 2010)
- The Service will continue to monitor the acceptance of Hesperidanthus as the correct genus for this species and will officially change this species' name through an FR notice as needed. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***
- Recommended future actions: We recommend increased surveys of potential suitable habitat on all landowner types to better estimate total number of individuals, delineate populations, identify important connectivity corridors, and allow planning for landscape level protections. Additional research that provides a better understanding of current population demographics, population trends, and impact of threats is also necessary to evaluate the effectiveness of current protections and identify when recovery criteria are met. The designation and management of protected areas that reduce impacts from identified threats remains necessary to facilitate this species' recovery. Additionally, we recommend revising the recovery plan and specifically reevaluating the recovery goals and criteria based on new population numbers, habitat requirements, connectivity analysis, and potential changes in threat type and intensity. (USFWS, 2019a)
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1) Reestablish and continue the long-term demographic monitoring across the range of H. suffrutescens. Incorporate plant community data collection. 2) Continue to survey potential habitat across the range focusing on the gaps between, and the edges of, known populations. This would help address downlisting criteria one. 3) Development of a management plan or a formal land designation by the Bureau of Land Management and partner agencies with assistance from the Service. These plans should address current effects from building stone removal and livestock grazing, as well as new or emerging threats such as climate change (USFWS, 2024).

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# SPECIES ACCOUNT: *Schwalbea americana* (American chaffseed)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/29/1992; Southeast Region (Region 4)

**Physical Description**

Schwalbea is an erect herb with unbranched stems or stems branched only at the base, growing to a height of3.0 to 6.0 dm (12 to 24 in). The plant is densely albeit minutely hairy throughout, including the flowers. The leaves are alternate, lance-shaped to elliptic, stalkless, 2.5 to 5.0 cm (0.8 to 2 in) long, and entire; the upper leaves are reduced to narrow bracts. The large, purplish-yellow, tubular flowers, 3.0 to 3.5 cm long (1.2 to 1.4 in) are borne singly on short stalks in the axils of the uppermost, reduced leaves (bracts) and form a many flowered, spike-like raceme. The showy flowers have a high degree of bilateral symmetry elaborated for pollination by bees (Pennell 1935). The fruit is a narrow capsule approximately 10 to 12 mm (0.4 to 0.5 in) long, with a septicidal dehiscence. The numerous seeds are pale greenish brown or yellowish-tan, narrowly linear, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting, sac-like structure that provides the basis for the common name, chaffseed (Musselman and Mann 1978). Flowering occurs from April to June in the southern part of the species' range, and from June to mid-July in the northern part of its range. Fruits mature from early summer in the South to October in the North (Johnson 1988). (USFWS, 1995)

**Taxonomy**

Pennell (1935) recognized a northern and southern species of Schwalbea, Schwalbea americana L. and Schwalbea australis Pennell, respectively. He distinguished Schwalbea americana by mostly recurved hairs and leaves up to 1.0 cm (0.4 in) wide or less, and Schwalbea australis by a pubescence of mostly upcurved hairs and leaves up to 1.5 cm (0.6 in) wide. Schwalbea americana was known from Massachusetts southward to Virginia, and Schwalbea australis was known from North Carolina to Kentucky and southward to Florida and Louisiana. Fernald (1937) found characters of the leaves and calyx lobes to vary over the total range so that recognition of two species was unwarranted. Following an examination of herbarium material, Musselman and Mann (1977) concurred that there was little taxonomic merit in recognizing more than a single species. Therefore, the U.S. Fish and Wildlife Service accepts the more recent treatments of Fernald (1937) and Musselman and Mann (1977), which recognize Schwalbea americana and Schwalbea australis as one species, Schwalbea americana. In this plan, SchwaIbea americana will be henceforth referred to as the monotypic genus Schwalbea. (USFWS, 1995)

**Historical Range**

Historically known from Massachusetts and New York south along the East Coast to Florida and west along the Gulf Coast states to Texas. (NatureServe, 2015)

**Current Range**

Currently found in the following states: Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, Alabama, Florida, and Louisiana. (USFWS, 2019a)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual and sexual (outcrossing) (NatureServe, 2015)

**Dependency on Other Individuals or Species**

Adult: Schwalbea produces showy, insect-pollinated flowers with a high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). (USFWS, 1995)

**Breeding Season**

Adult: April to June (USFWS, 1995)

**Other Reproductive Information**

Adult: The germination rates of collected Schwulbea seeds are high. Kirkman (1993) reported that the germination rate of seeds placed in petri dishes, with and without cold stratification, was approximately 90 percent. (USFWS, 1995)

**Reproduction Narrative**

Adult: This species produces showy, insect-pollinated flowers; the high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). Reproduction primarily occurs via outcrossing (sexual) but can also reproduce asexually. Flowers bloom between April and June. (USFWS, 1995; NatureServe, 2015)

**Habitat Type**

Adult: Palustrine and terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Bog/fen, forest/woodland, savanna, woodland - mixed (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Sunny open areas (NatureServe, 2015)

**Environmental Specificity**

Adult: Sunny areas (NatureServe, 2015)

**Dependency on Other Individuals or Species for Habitat**

Adult: The root parasitic behavior of Schwalbea has been known since 1856 (Musselman and Mann 1977). Schwalbea is considered the rarest root parasitic plant in the South, and, like most parasitic Scrophulariacese, it is not host-specific. (USFWS, 1995)

**Habitat Narrative**

Adult: Characteristically, Schwalbea occurs in sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. The species is generally found in habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (Kral 1983). Schwalbea appears to be shade intolerant and, therefore, occurs in areas maintained in an open to partially open condition. In Georgia, Scwalbea occurs in ecotonal areas between freshwater wetlands and upland pine forests. In North Carolina, the species occurs in moist to dryish pine flatwoods, longleaf pine/wiregrass savannas, and on longleaf pine/oak sandhills composed of Upper Cretaceous deep, white sands, at the western edge of the coastal plain. In South Carolina, the predominant habitat is described as fire-maintained (or mowed, as under power lines), dry, well-drained, longleaf pine flatwoods. The soil is generally a sandy loam. In New Jersey, Schwalbea occurs in open areas that have been maintained by mowing within a pitch pine community. The site is next to a roadcut through a cedar swamp. (USFWS, 1995)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: The structure of the Schwalbea seed, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting sac-like structure, suggests wind dispersal; however, no information is available to support this hypothesis. Information is lacking on both the mechanism and distance of seed dispersal. (USFWS, 1995)

***Population Information and Trends***

**Population Trends:**

Long-term trends indicate population declines from 50 to 90%, whereas short-term trends suggest declines of 10 to 30% (NatureServe, 2015)

**Species Trends:**

Declining (NatureServe, 2015)

**Number of Populations:**

43 (USFWS, 2019a)

**Population Size:**

2500 - 10,000 individuals (NatureServe, 2015)

**Adaptability:**

Moderate (NatureServe, 2015)

**Population Narrative:**

When Schwalbea was listed as an endangered species in 1992, 19 extant occurrences were known from the following States: New Jersey (1), North Carolina (1), South Carolina (11), Georgia (4), Florida (1), and Mississippi (1). At the completion of the recovery plan in 1995, extensive searches for this species that occurred in the Southeast, namely North and South Carolina, increased the number of extant occurrences to 72: New Jersey Pleasantville, New Jersey(1), North Carolina (18), South Carolina (42), Georgia (10), and Florida (1). The last comprehensive review of this species status occurred in 2008. At that time, 53 occurrences were extant (30% of sites extant) in 2008: New Jersey (2), North Carolina (11), South Carolina (33), Georgia (4), Alabama (1), Florida (1), and Louisiana (1). It is important to note that in the 1995 recovery plan and 2008 5-year review, the terms population and occurrence were used interchangeably. Since some Schwalbea populations have multiple element occurrences or sites per population, the number of populations across the species range was over-reported in some cases. In order to standardize population numbers across state boundaries, NatureServe's (2018) population delimitation guidelines were used for all extant populations across Schwalbeas' range in this five-year review. Historic and unknown occurrences were not delimited. Currently, there are 43 extant populations across the species range: Massachusetts (1), New Jersey (2), North Carolina (6), South Carolina (18), Georgia (9), Alabama (2), Florida (3), and Louisiana (2). (USFWS, 2019a)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat destruction and adverse modification of suitable habitat for Schwalbea continue to be major threats for this species. Development along the coast continues to threaten Schwalbea by (1) direct loss of habitat and (2) indirect threats due to urbanization resulting in fire suppression from either local air pollution regulations or safety concerns. Fire suppression continues to threaten this species on both private and public lands. Conversion of longleaf flatwoods and savannas to commercial pine plantations and agriculture fields continue to threaten this species. Although new Schwalbea populations are being discovered, the number of extant populations declined by approximately 25% since the last 2008-five year review. (USFWS, 2019a)

**Stressor:** Herbivory (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory continues to serve as a minor threat to the species, herbivores include the striped leaf beetle (Kuschelina sp.), Chrysomelid leaf beetle sp., and Buckeye caterpillar (Junonia coenia) larvae (M. Jenkins, Florida Department of Agriculture and Consumer Resources, pers. comm. 2017; Bob Dellinger, U.S. Forest Service, pers. comm. 2017). The Lethcoe, FMNF population suffered from herbivory when fresh new growth sprouted following a prescribed fire. (USFWS, 2019a)

**Stressor:** Small population size (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small population size was noted as a threat in the last 2008 five-year review and remains a threat today. Populations that appear stable throughout time contain at least 100 individuals. Currently, 20 populations contain 100 or more individuals. Small populations are highly vulnerable to extirpation, especially in the absence of prescribed fire. Small populations may be less resilient to environmental changes related to climate change. (USFWS, 2019a)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Because the Act only grants protection to plants when a Federal nexus is involved (e.g., federal permit required, federally funded projects), existing regulatory mechanisms are inadequate to protect Schwalbea. Schwalbea receives protection from state rare plant protection laws in Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, and Florida. (USFWS, 2019a)

**Stressor:** Drought (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Since Schwalbea is mostly (can occur outside of ecotone areas in longleaf flatwoods) an ecotone species occurring in transitional areas between uplands and freshwater wetlands, an increase in drought frequency and decrease in precipitation events could threaten smaller, less resilient populations. (USFWS, 2019a)

***Recovery***

**Reclassification Criteria:**
1. Long-term protection is achieved for 50 geographically distinct, self-sustaining populations. The population sites must be protected from development and other anthropogenic threats that may interfere with the species' survival. Protection of populations on private lands will be evidenced through landowner agreements or conservation easements. Protection of Schwalbea on public lands will be secured through agreements that ensure the long-range protection, management, and monitoring ofSchi4.ulbea. Protected sites will be distributed to include, at a minimum, all of the States currently supporting Schwalbea, with at least four populations in the northern portion of the species' range. Site protection agreements will cover the immediate occurrence site and, where possible, enough contiguous unoccupied habitat to allow for dispersal and natural colonization and expansion of the species. (USFWS, 1995)

2. Management agreements or plans are developed for the 5O protected occurrence sites with the primary objective of ensuring that an ecosystem capable of supporting viable populations of Schwalbea will be permanently maintained. In the case ofprivate ownership, these management agreements could be part of the conservation easement or landowner agreement. (USFWS, 1995)

3. Viable populations of Schwalbea are established at four sites in the northern portion of the species' range (Massachusetts to Virginia), preferably with genetic material from the only remaining northern population in New Jersey. (USFWS, 1995)

4. Biennial monitoring shows that the 50 protected populations are viable as well as stable or increasing over a 10-year period. Demographic population data will be required to meet this condition. (USFWS, 1995)

5. Life history and ecological requirements are understood sufficiently to reliably predict the effectiveness of protection, management, and monitoring. (USFWS, 1995)

**Delisting Criteria:**

1. Protection via a conservation mechanism is achieved for 50 geographically distinct, self-sustaining populations (Addresses listing factors A, D, and E). (USFWS, 2019b)

2. Protected populations will be distributed to include all of the states currently supporting Schwalbea, and at least four populations in the northern portion of the species range (Massachusetts to Virginia) (Addresses listing factors A, D, and E). (USFWS, 2019b)

3. The land management plans or agreements for the 50 protected Schwalbea populations must include management objectives that abate threats to Schwalbea such as fire suppression, hog damage, and/or silviculture practices (Addresses listing factors A, D, and E). (USFWS, 2019b)

**Recovery Actions:**

- Protect extant populations and manage habitat. Identify ownership of all known populations. Establish contact with landowners and negotiate landowner agreements or conservation easements. Ensure that activities and management on public lands are consistent with the protection and management of Schwalbea. Use existing regulatory mechanisms to protect Schwalbea. Conduct additional surveys. (USFWS, 1995)
- Expand the extent of Schwalbea In the northern portion of the current range. The New Jersey occurrence of Schwalbea, which is critical to maintaining the northern range of the species, will receive continued protection. In addition, populations should be established in New Jersey, Delaware, Maryland, New York, Connecticut, and Massachusetts to guard against the extirpation of the species from the northern portion of its range. Data are not currently available that indicate the genetic significance of the remaining northern population; however, Pennell (1935) considered the northern and southern populations of Schwalbea trlbea to be distinct species, with the southern species occurring as far north as Virginia (Reveal and Broome 1981). Genetic analyses (Recovery Task 6 below) may further support the significance of maintaining viable populations from the northern gene pool. (USFWS, 1995)
- Investigate best management techniques. ContInue experiments to determine the effects of fire. Conduct experiments to determine the effects of other disturbances. (USFWS, 1995)
- Investigate the species' biology. Conduct research to obtain more comprehensive information on life history and population demography. Determine minimum viable population size. (USFWS, 1995)
- Investigate genetic variability. Genetic analyses should be conducted to determine inter and intra-genetic variability of populations. Differences in the genetic composition of populations may influence site protection and reintroduction priorities. Ongoing genetic analyses may be sufficient to determine if significant variability exists. (USFWS, 1995)
- Monitor populations. Meeting the recovery objectives is contingent upon the stabilization of viable populations over time. Consistent monitoring will provide population data necessary to determine if the recovery objectives are being met. (USFWS, 1995)
- Review recovery progress and revise recovery plan as necessary. The overall success of the recovery program should be periodically assessed, and recommendations regarding appropriate changes in recovery objectives or tasks as suggested by research, studies, or monitoring should be implemented. (USFWS, 1995)
- Research and determine if in situ recruitment and reintroduction can occur under different levels of soil disturbance and watering regimes. (USFWS, 2019a)

- Continually search for new populations in areas managed for quail and/or red-cockaded woodpeckers or any areas with a 1-2 year fire return interval within the species' historic range. (USFWS, 2019a)
- Survey unknown and historic populations and if present negotiate landowner agreements or conservation easements. (USFWS, 2019a)
- Develop an easy and repeatable Schwalbea survey form and methodology for range-wide use in order to tract/monitor recovery populations annually. (USFWS, 2019a)
- Research the germination ecology of Schwalbea in regards to moisture and light requirements and seedling recruitment / host attachment to understand Schwalbea's regeneration strategy. (USFWS, 2019a)
- Research fire seasonality effects, especially early April and late July/August fires, in conjunction with rainfall patterns/climatic fluctuations. (USFWS, 2019a)
- Continue population reintroductions within the historic range and introductions into protected areas with 1-3 year fire return intervals. (USFWS, 2019a)
- Expand the extent of Schwalbea in the northern portion of the current range. (USFWS, 2019a)

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# SPECIES ACCOUNT: *Sclerocactus brevihamatus ssp. tobuschii* (Tobusch fishhook cactus)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** SCLTOB

**Listing Status:** Endangered; 12/08/1979; Southwest Region (Region 2)

### Physical Description

A cactus armed with fishhook-shaped spines. The hemispheric or short-columnar stems of mature plants are 3 to 10 centimeters (cm) (1.2 to 3.9 inches (in)) tall and 1 to 10 cm (0.4 to 3.9 in) in diameter; however, although the largest recorded individuals are as much as 10 cm ( 3.9 in) in diameter, few wild plants are greater than 5 cm (2.0 in) in diameter (Poole and Janssen 2002, p. 7). The stems are supported on short, conical taproots from which emerge numerous fibrous roots that typically grow horizontally along the surfaces and fissures of rock strata. The stems bear tubercles (podaria) up to 12 millimeters (mm) (0.5 in) long that have a groove (sulca) along their upper surfaces. The tubercles are arranged in 5 to 8 ribs (Marshall 1952, p. 79), or from 8 to 12 ribs (Poole et al. 2007, p.442). However, we note that the tubercles within each rib are nearly distinct from each other; the ribs, which may spiral, are difficult to discern, especially in smaller individuals, and the tubercles appear to alternate. Spines arise from areoles at the apex of each tubercle. The spines are of two types: Radial spines are fine, straight, from 1 to 2 cm (0.4 to 0.8 in) long, spreading at right angles to the tubercle from the edges of the areoles. From 3 to 5 thicker, flattened central spines, 2 to 4 cm (0.8 to 1.6 in) in length, arise from nearer the center of the areoles and project more or less outward from the stem; one of the central spines is abruptly recurved, and may reach 180° of curvature in older individuals. Spines are yellowish at first, and may have reddish tips, turning gray with age. Flowers emerge from the bases of young tubercles near the stem apex, and have numerous yellow tepals. Fruits are spineless, elongate, from 2.5 to 3 cm (1 to 1.2 in) long, turning reddish-green and usually splitting open along 1 or more lines when mature. (USFWS, 2017)

### Taxonomy

The genus Ancistrocactus, which means "fishhook", contains four species, three occurring in the region of the Rio Grande River in southern Texas and adjacent Mexico, and one occurring farther south (Benson, 1982). According to Benson (1982) this genus is mostly closely related to Coryphantha and Neolloydia, all three genera being in the vast complex group of plants intermediate between Mammillaria and Echinocactus. Systematics of the Cactaceae has always been controversial. No single treatment is universally accepted, and the steady accumulation of phylogenetic analyses has forced continual revisions. In particular, there is no consensus among cactus authorities regarding the taxa pertaining to the related genera of Ancistrocactus, Sclerocactus, and Ferocactus. The following sources provide a brief review of the prevailing classifications. A number of synonyms have been applied to this taxon, including Ancistrocactus tobuschii (W.T. Marshall) W.T. Marshall ex Backeb, Echinocactus tobuschii (W.T. Marshall) Weniger and Ferocactus tobuschii (W.T. Marshall) N.P. Taylor. (USFWS, 1987; USFWS, 2010). An extensive discussion of the taxonomy is provided in the Species Status Assessment of 2017 (USFWS, 2017).

**Historical Range**

Endemic to the Edwards Plateau of Texas. (USFWS, 2017)

**Current Range**

In the following central counties in Texas: Bandera, Edwards, Kerr, Kimble, kinney, Real, Uvalde, and Val Verde. (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2017)

**Lifespan**

Adult: >10 years (USFWS, 2017)

**Dependency on Other Individuals or Species**

Adult: Pollinators; most common were several species of halictid bees (USFWS, 2017)

**Breeding Season**

Adult: Late January to mid-March (USFWS, 2017)

**Other Reproductive Information**

Adult: Tobusch fishhook cactus plants begin reproducing when they have grown to a diameter of about 2 cm (occasionally less); this is estimated to require 9 years of growth in the wild. Flowering occurs between late January and mid-March, depending on locality, and lasts a few weeks in each population. Honey bees and halictid bees are effective pollinators, although the latter group may be more active later in the flowering season. The breeding system is primarily by outcrossing, although self-fertilization occurs rarely. Fruits ripen around mid-May. (USFWS, 2017)

**Reproduction Narrative**

Adult: Tobusch fishhook cactus grows slowly, reaching a reproductive size of about 2 centimeters (0.8 inches) in diameter after 9 years. It flowers between late January and mid-March, and its major pollinators are honey bees and halictid bees. The breeding system is primarily out-crossing, but the species is capable of self-fertilization. Reproductive individuals produce an average of 112 seeds per year. Ants may be seed predators, dispersers, or both. Mammals or birds may also accomplish longer-distance seed dispersal. We have little evidence of a persistent soil seed bank. (USFWS, 2017)

**Habitat Type**

Adult: Terrestrial (USFWS, 2017)

**Habitat Vegetation or Surface Water Classification**

Adult: Shortgrass grasslands, oak-juniper woodlands, semi-desert shrublands (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Full sunlight (USFWS, 2017)

**Spatial Arrangements of the Population**

Adult: Discontinuous patches (USFWS, 2018)

**Environmental Specificity**

Adult: Moderate, with some key requirements (USFWS, 2017)

**Habitat Narrative**

Adult: The riparian habitats described in the original status report are atypical. The great majority of documented populations occur in upland sites dominated by Ashe juniper-live oak woodlands and savannas on outcrops of early Cretaceous limestone. Soils are classified in the Tarrant, Ector, Eckrant, and similar series. Within a matrix of woodland and savanna, the species occurs in discontinuous patches of very shallow, gravelly soils where bare limestone rock and rock fragments comprise a large proportion of the surface cover. Associated vegetation includes small bunch grasses and forbs. The species' distribution within habitat patches is clumped and tends to be further from woody plant cover. The presence of spikemosses (Selaginella spp.), and perhaps other cryptogams, may be useful indicators of fine-scale habitat suitability. Wildfire (including prescribed burning) causes negligible damage to Tobusch fishhook cactus populations. The species probably does not require fire for germination, establishment, or reproduction, but periodic burning may be necessary to prevent the encroachment of woody plants into its habitats. (USFWS, 2017)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Ants remove a large proportion of seeds, pulp, and funiculi, but whether the ants consume the seeds, or effectively disperse them, is not known. Mammals or birds also consume fruits and may accomplish longer-distance seed dispersal. Moderate numbers of viable seeds have been found in the soil near live plants, but the extent and longevity of soil seed banks is unknown. (USFWS, 2017)

***Population Information and Trends***

**Population Trends:**

Increasing (USFWS, 2017)

**Resiliency:**

It is likely that Tobusch fishhook cactus has multiple, resilient populations (USFWS, 2017). 'Resilience and Redundancy. Resilience refers to the population size necessary to endure stochastic environmental variation (Shaffer and Stein 2000, pp. 308-310). Redundancy refers to the number and geographic distribution of populations or sites necessary to endure catastrophic events (Shaffer and Stein 2000, pp. 308-310). The recovery plan (USFWS 1987, p. 14) established a recovery criterion of 4 protected populations with at least 3,000 individuals, but did not show

how this level was determined. However, we now understand that insect parasites are able to devastate large, dense populations. We conclude that few large populations are much more vulnerable than many small populations, and that this recovery criterion should be amended. Poole and Birnbaum (2003, p. 1), using the surrogate species method of Pavlik (1996, pp. 136-137), estimated a MVP for Tobusch fishhook cactus of 1,200 individuals (Section II.7.5). Since few individual colonies reach this size, and since large colonies are more vulnerable to insect parasites, we recommend that the MVP of 1,200 individuals be applied to metapopulations that consist of multiple colonies distributed at a landscape scale. The resilience of Tobusch fishhook cactus derives not merely from the size of metapopulations, but also their density. Colonies that are too small or too isolated may incur loss of genetic diversity and inbreeding; Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8 populations, which he attributed to mating of close relatives within small, isolated populations. Conversely, vulnerability to insect parasitism increases when metapopulations become too dense, or when colonies become too large. Therefore, we believe that there must be some optimal range of metapopulation density and colony size, although we do not currently know what those optima are. These concepts of metapopulation size and density depend on how metapopulation boundaries are delimited. The EO concept is a good starting point, but may have to be revised for Tobusch fishhook cactus considering its specific population dynamics. The determination of Tobusch fishhook cactus viability is more challenging, since few surveys have been conducted on the roughly 95 percent of the potential habitat that is privately owned. Furthermore, since the populations are small and widely distributed, there is a low probability of detecting populations on any fixed area, such as a state park. It is likely that metapopulations are distributed over areas that are larger than individual parks and natural areas. We can speculate that the population densities found on the small number of areas that have been quantitatively surveyed are representative of the entire global distribution of this subspecies. Since 2009, several new quantitative surveys were conducted for highway, pipeline, and power line developments. These surveys provided data from transects that cross the subspecies' range and provide more evidence for its range of densities. Based on all available evidence, we provisionally estimate that the global population size is about 480,000 individuals (Appendix 2). Regardless of how this number is divided into metapopulations, we believe that it is likely that Tobusch fishhook cactus has multiple, resilient populations' (USFWS, 2017).

**Representation:**

Tobusch fishhook cactus currently possesses sufficient genetic diversity to conserve long-term adaptive capability. However, habitat fragmentation and disruption of gene flow among populations may have occurred too recently to be detected through genetic analyses. Considering the naturally low densities of Tobusch fishhook cactus populations, gene flow among them may be easily disrupted. (USFWS, 2017). Representation. Representation refers to the genetic diversity, both within and among populations, necessary to conserve long-term adaptive capability (Shaffer and Stein 2000, pp. 307-308). Rayamajhi (2015, (pp. 53, 54, 65, 66, 79, 80) found relatively low levels of genetic differentiation among 9 populations of Tobusch fishhook cactus (low pairwise FST and GST levels, discussed in II.2), regardless of the distance between populations. He found evidence of substantial gene flow among populations, suggesting that the documented populations may interact with additional (undocumented) populations (at least in the recent past) (p. 67). However, recently isolated populations may not yet show genetic differentiation, in part because individuals can live and contribute to the local gene pool at least for several decades. Most of the populations studied had healthy levels of outbreeding, but 3 populations were at relatively higher risk of inbreeding effects and may have suffered recent genetic bottlenecks through population declines (P. 97). Based on controlled pollination experiments, Emmett (1995) found effective fertilization (fruit set, seed production, and seed viability) within isolated colonies in his study area (p. 87). This affirms empirically that at least some isolated colonies still possess a sufficient level of genetic diversity. The low level of genetic differentiation among populations is not unusual for endemic taxa, and may also indicate a fairly recent divergence of subspecies tobuschii from subspecies brevihamatus. There is evidence of gene flow throughout the subspecies' range and possible interaction of the monitored populations with undocumented populations on surrounding private lands. Genetic differentiation within most, but not all populations, is sufficiently high for effective fertilization and out-crossing. We conclude that Tobusch fishhook cactus currently possesses sufficient genetic diversity to conserve long-term adaptive capability. However, habitat fragmentation and disruption of gene flow among populations may have occurred too recently to be detected through genetic analyses. Considering the naturally low densities of Tobusch fishhook cactus populations, gene flow among them may be easily disrupted. Therefore, maintaining the continuity of potential habitats throughout the subspecies range should have a high conservation priority. We recommend that viability monitoring should be continued long enough to determine population dynamics and demographic trends at the metapopulation and subspecies levels (USFWS, 2017).

**Redundancy:**

It is likely that Tobusch fishhook cactus has multiple, resilient populations (USFWS, 2017). 'Resilience and Redundancy. Resilience refers to the population size necessary to endure stochastic environmental variation (Shaffer and Stein 2000, pp. 308-310). Redundancy refers to the number and geographic distribution of populations or sites necessary to endure catastrophic events (Shaffer and Stein 2000, pp. 308-310). The recovery plan (USFWS 1987, p. 14) established a recovery criterion of 4 protected populations with at least 3,000 individuals, but did not show how this level was determined. However, we now understand that insect parasites are able to devastate large, dense populations. We conclude that few large populations are much more vulnerable than many small populations, and that this recovery criterion should be amended. Poole and Birnbaum (2003, p. 1), using the surrogate species method of Pavlik (1996, pp. 136-137), estimated a MVP for Tobusch fishhook cactus of 1,200 individuals (Section II.7.5). Since few individual colonies reach this size, and since large colonies are more vulnerable to insect parasites, we recommend that the MVP of 1,200 individuals be applied to metapopulations that consist of multiple colonies distributed at a landscape scale. The resilience of Tobusch fishhook cactus derives not merely from the size of metapopulations, but also their density. Colonies that are too small or too isolated may incur loss of genetic diversity and inbreeding; Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8 populations, which he attributed to mating of close relatives within small, isolated populations. Conversely, vulnerability to insect parasitism increases when metapopulations become too dense, or when colonies become too large. Therefore, we believe that there must be some optimal range of metapopulation density and colony size, although we do not currently know what those optima are. These concepts of metapopulation size and density depend on how metapopulation boundaries are delimited. The EO concept is a good starting point, but may have to be revised for Tobusch fishhook cactus considering its specific population dynamics. The determination of Tobusch fishhook cactus viability is more challenging, since few surveys have been conducted on the roughly 95 percent of the potential habitat that is privately owned. Furthermore, since the populations are small and widely distributed, there is a low probability of detecting populations on any fixed area, such as a state park. It is likely that metapopulations are distributed over areas that are larger than individual parks and natural areas. We can speculate that the population densities found on the small number of areas that have been quantitatively surveyed are representative of the entire global distribution of this subspecies. Since 2009, several new quantitative surveys were conducted for highway, pipeline, and power line developments. These surveys provided data from transects that cross the subspecies' range and provide more evidence for its range of densities. Based on all available evidence, we provisionally estimate that the global population size is about 480,000 individuals (Appendix 2). Regardless of how this number is divided into metapopulations, we believe that it is likely that Tobusch fishhook cactus has multiple, resilient populations' (USFWS, 2017).

**Number of Populations:**

511 sites (USFWS, 2017)

**Population Size:**

Globally about 480,000 individuals (USFWS, 2017)

**Population Narrative:**

The TXNDD (2016) lists 97 EOs, totaling 3,336 individuals in 8 counties of the Edwards Plateau of Texas. • From 2009 to 2016 we received additional sources of population data, primarily from surveys conducted for development projects. • A total of 118 permanent plots at 12 protected natural areas have been monitored from 1991 through 2013. Plot data reveals that mortality is often very high, and consistently exceeds recruitment; however, the known population sizes have steadily increased, due to the discovery of previously undetected individuals and colonies. • The probability of detecting live Tobusch fishhook cactus individuals during a single survey is highly variable; Reemts (2014) calculated an overall detection rate of 50 percent. The inability to detect all living members of a population confounds determinations of population size and demographic trends. • Demographic population viability analyses of monitored populations, using integral projection models, predicted stable or increasing trends for 2 or 3 populations, moderate declines for 2 populations, and large to precipitous declines in 5 populations over the next 50 years. When expected climate changes were included in the analyses, 4 populations responded negatively to climate changes and 6 populations responded positively (compared to PVA without climate changes). We estimate that the global population size for Tobusch fishhook cactus is about 473,000 individuals distributed over an area of over 2 million ha (5 million ac). (USFWS, 2017)

***Threats and Stressors***

**Stressor:** Land Use Changes (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Relatively little urban and industrial development is occurring within the semi-arid, sparsely populated eight-county known range of Tobusch fishhook cactus. However, a significant ongoing trend throughout the species' range is the subdivision of large ranches into many small "ranchettes," leading to a proliferation of roads, fences, power lines, and residential development, all of which contribute incrementally to habitat loss and fragmentation. Land subdivision also engenders changes in land use and management which may be both beneficial and detrimental to Tobusch fishhook cactus. For example, the predominant, historic land use

throughout the Edwards Plateau has been grazing of livestock, including goats, cattle, sheep, and horses. In many cases, poor rangeland management during the last century has caused the depletion of herbaceous vegetation, cessation of the natural wildfire cycle, proliferation of dense juniper stands, soil erosion, and reduced infiltration and storage of rainwater in the soil profile; all of these changes are likely to have harmed Tobusch fishhook cactus populations. The change to a primarily recreational land use often entails continued grazing, in order to obtain agricultural tax exemptions, but at a sustainable stocking density (landowners may subsequently convert an agricultural exemption to a wildlife exemption). Currently, both large and small landowners are more aware of and concerned with conservation issues than during the last century. Prescribed burning may be one of the most important vegetation management tools for sustaining Tobusch fishhook cactus populations; the proliferation of residential development within the species' habitat makes this tool more challenging for natural resource managers to use. The subdivision of privately-owned land and associated threats are likely to continue. (USFWS, 2017)

**Stressor:** Changes in vegetation and wildfire frequency. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Bray (1904, pp. 14–15, 23–24) documented the rapid transition of grasslands to woodlands in the Edwards Plateau occurring more than a century ago; he attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. Fonteyn et al. (1988, p. 79) state that savannas covered portions of the pre-settlement Edwards Plateau, and since 1850 were transformed to shrubland or woodland "primarily by suppression of recurring natural and anthropogenic fires and the introduction of livestock." They list the fire-sensitive Ashe Juniper as the most successful of many woody plants that have invaded grasslands. Reemts (2014 p. 1). lists the encroachment of woody plants into the rocky, open habitat as one of several habitatrelated threats to Tobusch fishhook cactus. However, the historic extent of grasslands in the Edwards Plateau is an area of active scientific debate. It is likely that woodlands were most abundant on slopes in the Balcones Escarpment (which includes the southern and eastern portion of the Tobusch fishhook cactus range) and that grasslands were more abundant on flatter, deeper soils in the western Edwards Plateau (Diamond et al. 1995, pp. 191-193; Diamond and True 2008, pp. 53-54; Murray et al. 2013, pp. 298, 302). (USFWS, 2017)

**Stressor:** Livestock grazing. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The recovery plan stated "Ancistrocactus tobuschii plants have been observed that were either uprooted or had apical meristem injuries from livestock trampling." Nevertheless, livestock trampling and herbivory have not subsequently been identified as significant causes of mortality or damage to Tobusch fishhook cactus plants. The recurved spines and small size probably discourage herbivory of Tobusch fishhook cactus plants. Livestock are not attracted to the sparsely vegetated outcrops where Tobusch fishhook cactus plants typically occur, and the plants are protected to some degree by surrounding rocks. While livestock trampling probably occurs in grazed habitats, particular where animals are concentrated, we have no evidence that it represents a significant threat to the species. A number of healthy Tobusch fishhook cactus populations occur on well-managed rangeland. We conclude that livestock grazing, especially where juniper thinning and prescribed burning are used to manage rangeland, is generally

compatible with conservation of this cactus. (USFWS, 2017)

**Stressor:** Illicit collection. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Many rare cactus populations have been depleted by overzealous collectors. The recovery plan lists collection by unscrupulous cactus and succulent fanciers as a threat to the species. Westlund (1991, pp. 2, 35, 39) found six specimens of Tobusch fishhook cactus, grown legally from seed, for sale in commercial nurseries. Poole and Janssen (2002, p.9) noted that one population of Tobusch fishhook cactus was heavily depleted by collection, but concluded that "collection is not currently perceived to be a grave threat." Although illicit collection has not significantly impacted the species, the wild populations openly accessed by the public remain vulnerable. The potential threat of illicit collection might be diminished if seeds and plants of legally-propagated Tobusch fishhook cactus are easier and less expensive to obtain than wilddug specimens. (USFWS, 2017)

**Stressor:** Parasites. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Tobusch fishhook cactus weevil (Gerstaeckeria sp. nov.) and cactus longhorn beetle (Moneilema spp.) parasitize and kill Tobusch fishhook cactus plants and have contributed significantly to drastic declines in many of the known populations (Calvert 2003, all). Considering that the weevil (Gerstaeckeria sp. nov.) is a new species, and that it may be an obligate parasite of Tobusch fishhook cactus (Calvert 2003, p. 12), the weevil itself may be no less endangered than its host. Periodic outbreaks of insect parasitism appear to be an unavoidable natural cycle. For this reason, the recovery criterion of 3,000 individuals per population may be unattainable or unsustainable, as such large cactus populations would eventually host very large parasite populations, leading to their collapse. The most appropriate conservation strategy may be to protect larger numbers of small, widely-spaced populations, rather than fewer large populations that are more vulnerable to parasites; however, we do not currently know what the optimal parameters of size and spacing should be..(USFWS, 2017)

**Stressor:** Other herbivory. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Poole and Birnbaum (2003, pp. 11-12) report that jackrabbits browse the cactus, but in most sites cause less than 2 percent mortality. If the root systems are not too badly damaged, they may regenerate one or more new stems. Feral hogs have uprooted plants in many sites (also observed by Reemts (2015, p. 1)). An unidentified ant species has also caused 1 percent mortality at some sites by creating mounds on top of the stems. Federally-listed plants occurring on private lands have limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Approximately 95 percent of Texas land area is privately-owned. It is reasonable to assume that the vast majority of existing Tobusch fishhook cactus habitat, including sites that have not been documented, occurs on private land. Therefore, most of the species' populations and habitats

are not subject to Federal or State protection unless there is a Federal nexus, such as provisions of the Clean Water Act or a federally-funded project. The ESA does provide some protection for listed plants on land under Federal jurisdiction. However, Tobusch fishhook cactus populations have not been documented on Federal land. International trade of Tobusch fishhook cactus (as Sclerocactus brevihamatus ssp. tobuschii) is regulated under CITES Appendix I (Convention on International Trade in Endangered Species of Wild Fauna and Flora 2009). (USFWS, 2017)

**Stressor:** Demographic consequences of small population size and density. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Poole and Birnbaum (2003, p. 1) estimated an MVP of 1,200 individuals (Section II.7.5). Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000, pp. 308-310), such as fluctuations in recruitment (demographic stochasticity), variations in rainfall (environmental stochasticity), or changes in the frequency of wildfires. Tobusch fishhook cactus has a predominantly out-crossing breeding system. The probability of successful fertilization between unrelated individuals is reduced in small, isolated populations. The remaining plants would produce fewer viable seeds, further reducing population recruitment and engendering a downward spiral toward extirpation. The demographic consequences of small population size are compounded by genetic consequences (discussed below), since reduced out-crossing corresponds to increased inbreeding. In addition to population size, it is likely that population density also influences population viability; density must be high enough for gene flow within metapopulations, but low enough to minimize parasite infestations. (USFWS, 2017)

**Stressor:** Genetic consequences of small population sizes. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small, reproductively isolated populations are susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding. The loss of genetic diversity may reduce the ability of a species or population to resist pathogens and parasites, to adapt to changing environmental conditions, or to colonize new habitats. Conversely, populations that pass through a “genetic bottleneck” may subsequently benefit through the elimination of harmful alleles. Nevertheless, the net result of loss of the genetic diversity is likely to be a loss of fitness and lower chance of survival of populations and of the subspecies. Genetic drift is a change in the frequencies of alleles in a population over time. Genetic drift can arise from random differences in founder populations and the random loss of rare alleles in small isolated populations. Genetic drift may have a neutral effect on fitness, but is also a cause of the loss of genetic diversity in small populations. Genetic drift may also result in the adaptation of an isolated population to the climates and soils of specific sites, leading to the development of distinct ecotypes and to speciation. For example, the genetic divergence of Sclerocactus brevihamatus subspecies brevihamatus and tobuschii (Section II.2; Rayamajhi 2015, pp. 67, 98) may have resulted when populations of the species brevihamatus migrated into separate geographic regions, and once separated, each population adapted to different soils, climate, and pollinator species. Inbreeding depression is the loss of fitness among offspring of closely related individuals. While most animal species are susceptible to inbreeding depression, plant species vary greatly in response to inbreeding. Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8

populations, which he attributed to mating of close relatives within small, isolated populations. Nevertheless, we do not know to what extent inbreeding has reduced fitness of these populations. (USFWS, 2017)

**Stressor:** Private land ownership. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A large portion of the known individuals and populations of Tobusch fishhook cactus occurs on privately owned land. This does not constitute a threat to the subspecies, and in fact many landowners have demonstrated interest and enthusiasm for its conservation. However, private ownership makes conservation more challenging for several reasons. Access to populations and habitats is subject to the interests of hundreds of individual landowners. Consequently, our knowledge of the subspecies' actual status is far from complete. Establishing and maintaining cooperative relationships with large numbers of private landowners is time-consuming, and these important relationships may lapse when personnel of conservation organizations retire or pursue other career choices. The ownership of private lands changes hands over time, and future owners may choose not to continue conservation efforts that were supported by previous owners. Hence, it is difficult to assure permanent conservation on private lands. These challenges underscore the importance of effective landowner outreach in the conservation of Tobusch fishhook cactus. (USFWS, 2017)

**Stressor:** Climate change. (USFWS, 2017)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; it is very likely that the frequency, intensity, and/or amount of heavy precipitation will increase in mid-latitude land masses; it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. We do not know how Tobusch fishhook cactus responded to prior climate changes, nor can we determine how these projected climate changes, forecast by the range of models and emissions scenarios, will affect the synecology of Tobusch fishhook cactus and its habitat. Warmer winters could extend the growing season and improve reproduction and survival of Tobusch fishhook cactus, but might also increase survival of parasite larvae. Heavier, less frequent rainfall could reduce establishment of Tobusch fishhook cactus seedlings, but perhaps less so than the bunch grasses that it competes with. Zaya et al. (2014, pp. 37-38) projected that expected climate changes will be detrimental to 4 populations and beneficial to 6 others. Thus, although it is likely that the projected climate changes will affect the survival of Tobusch fishhook cactus in infinitely complex ways, we do not currently know what the net result of beneficial and detrimental effects will be. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
No longer applicable due to revision to Threatened status. (USFWS, 2018)

Recovery Priority Number: 9C

**Delisting Criteria:**
1. Populations or portions of metapopulations occur within 10 or more protected natural areas. Protected natural areas include lands owned by federal, state, or local government agencies, or by private landowners, that are legally protected for the purpose of conserving native plants and animals and their habitats. Examples include, but are not limited to, state parks, state natural areas, and state wildlife management areas, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with other public agencies or private landowners. To be considered under this criterion, the potential habitats of Tobusch fishhook cactus must be managed in a manner that promotes the continued survival of the subspecies. (USFWS, 2019)

2. The 10 or more protected natural areas described in the previous criterion must conserve the full geographic and ecological range of the subspecies. To meet this criterion, one or more protected natural areas must occur within each of four equal-area quadrants (northeast, northwest, southeast, and southwest) of the subspecies' natural range. (USFWS, 2019)

3. Populations or portions of metapopulations within each protected natural area have 1,200 or more mature individuals. This criterion may be met by combining multiple protected areas that occur within the same metapopulation, as defined above. (USFWS, 2019)

4. Periodic monitoring indicates that the minimum viable population level of 1,200 mature individuals within each protected natural area has remained stable or has increased over a period of 45 years. Monitoring (censuses) of each protected natural area must be conducted at least once every 5 years. The size of large populations may be estimated through statistically valid sampling methods. (USFWS, 2019)

**Recovery Actions:**
- 1. Remove immediate human threats to Ancistrocactus tobuschii by protecting known populations from collecting and habitat destruction. (USFWS, 1987)
- 2. Establish a permanent living collection at a botanical garden or university. Even though plants in a living collection can not substitute for healthy populations in natural habitats, a living collection would still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent well documented and accessible living collection, together with appropriate seed banking, could provide an important source of material for non-destructive research, maintenance of wild popula- tions, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1987)
- 3. Minimize long-range threats to Ancistrocactus tobuschii by development of biological information relevant to recovery. A better understanding of the demography of populations and the life history and ecological requirements of the species would provide information useful to management. (USFWS, 1987)

- 4. Establish a long-term (five year) survey program to more precisely determine the true distribution of the species. Surveys for this cactus will be difficult because it is easily overlooked, particularly in the summer and fall when it is hidden by perennial grasses. (USFWS, 1987)
- 5. Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial artificial propagation program. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. (USFWS, 1987)
- 6. Develop a program to provide propagated plants and seeds to the commercial market. If information from task 5 indicates that artificial propagation will reduce collecting from the wild, an effort should be made to see that adequate sources of propagated plants are commercially available. This may be particularly helpful for Ancistrocactus tobuschii because several of the historic sites are easily accessible and already well known from the literature. (USFWS, 1987)
- 7. Develop public awareness, appreciation, and support for preservation of the species. Public education is extremely important to this species' successful recovery. Landowners usually do not realize that this species exists and most will support protection and con-servation efforts if they learn that a unique plant grows on their land. (USFWS, 1987)
- Recommended Future Actions from 2010 5-Year Review: 1. Continue monitoring and surveying the established protected reserves. 2. Conduct surveys of high-potential habitat within the known range of the species, focusing on sites that have not previously been surveyed. 3. Establish new reserves, using the LBJWC conservation fund and other resources. 4. Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group, similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus). 5. Continue to investigate ecology and management, with special emphasis on woody plant control and prescribed burning; compare effects of prescribed burning conducted at different times of the year. 6. Investigate the factors influencing reproduction and dispersal in the wild, with emphasis on the fate of seeds collected by ants. 7. Apply sound management, as needed, to protected sites. 8. Investigate the phylogenetic and taxonomic relationship between Sclerocactus brevihamatus ssp. brevihamatus, S. brevihamatus ssp. tobuschii, S. scheeri, and other closely related taxa of Sclerocactus and/or Ancistrocactus. 9. Collect seeds of representative populations for propagation and seed banking, establish germ-plasm (live plant) refugia, and develop techniques for successful propagation and reintroduction. 10. Revise the 1987 recovery plan. (USFWS, 2010)

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# SPECIES ACCOUNT: *Sclerocactus brevispinus* (Pariette cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 09/15/2009; Mountain-Prairie Region (R6) (USFWS, 2016)

**Physical Description**

Small cactus with very short (2 mm) central hooked or straight spines. (NatureServe, 2015)

**Taxonomy**

The original listing rule for S. glaucus (44 FR 58868, October 11, 1979) included all hookless (straight central spines) Sclerocactus populations in western Colorado and northeastern Utah, and referred to them as S. glaucus per Benson (1966, pp. 50-57; 1982, pp. 728-729). This taxonomic classification is not supported by the results of more recent research. Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993; Welsh et al. 2003), and a reevaluation of the morphological characteristics of S. glaucus, led to separating this species into three distinct species: S. brevispinus, S. glaucus, and S. wetlandicus (Hochstätter 1993; Heil and Porter 2004). We recognized these three distinct species as threatened on September 15, 2009 (74 FR 47112). The Flora of North America recognizes 15 species in the genus Sclerocactus, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between S. brevispinus and S. wetlandicus, but infer S. glaucus is more closely related to S. parviflorus (Devil's claw cactus) and S. whipplei (Whipple's fishhook cactus). The common name for S. glaucus was changed to Colorado hookless cactus as the species is endemic to western Colorado. S. wetlandicus is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. S. brevispinus is now known as the Pariette cactus as it is limited to the Pariette Draw of the central Uinta Basin. The Uinta Basin hookless cactus complex will be used to refer to the combination of all three species previously listed as a single entity (USFWS, 2010)

**Current Range**

Known only from a single area a few miles across in the Pariette Draw region of Duchesne County, Utah, U.S.A.

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Predominately insect pollinated (surrogate S. glaucus information) (USFWS, 2007)

**Breeding Season**

Adult: Flowering occurs in April-May, and fruits mature in May-June (surrogate S. glaucus information) (NatureServe, 2015).

**Reproduction Narrative**

Adult: Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantely outcrossing but is marginally self-compatible. Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of Sclerocactus glaucus (NatureServe, 2015). Information from S. glaucus is being used a surrogate information for S. wetlandicus due to the species similiarities and based on the following quote 'Because we lack life history data specific to S. wetlandicus, we have included life history data for S. glaucus, which should correlate to characteristics for S. wetlandicus' USFWS, 2010. Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water;  (NatureServe, 2015). The species' life history is poorly known, but it is thought to be a longlived perennial usually flowering after 3 or 4 years. A broad assemblage of native bees, and possibly other insects including ants and beetles, pollinates S. brevispinus (USFWS 1990, p. 7) (USFWS, 2007).

**Habitat Type**

Adult: Clay badlands (NautreServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species is endemic to highly saline and alkaline soils, restricted to clay badlands within a single geologic formation in Utah. Occurs on exposed clay hills and in saltbush and sagebrush flats, 1400-1500 m. (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species habitat requirements of the species and the relatively small geographic area this species inhabits.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Unknown

**Population Size:**

between 30,500 and 42,281 individuals (USFWS, 2020)

**Population Narrative:**

Cumulative survey data represents the best scientific information available regarding the number of individuals for Sclerocactus. The known range-wide population size for Uinta Basin hookless cactus is between 83,408 and 110,815 individuals, and the known range-wide population size for Pariette cactus is between 30,500 and 42,281 individuals (USFWS 2019).

(USFWS, 2020)

***Threats and Stressors***

**Stressor:** Oil and Gas Development and Associated Impacts (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The BLM is monitoring S. brevispinus populations and neighboring Sclerocactus species, including impacts associated with oil and gas development. Initial results show potential effects of oil and gas development (i.e., roads and well pads) on the survival and reproductive success of S. brevispinus (72 FR 53215, September 18, 2007) (USFWS, 2010.

**Stressor:** Collection (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Illegal collection is a significant threat to S. brevispinus. The original listing of S. glaucus concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductive population. As of 2006, approximately 96 percent of the known range of S. brevispinus (at the time, 5,733 ha or 14,166 ac) was within 400 m (1,312 ft) of a well (Service 2006). Such development facilitates human access and discovery by illegal collectors (72 FR 53216, September 18, 2007) (USFWS, 2010).

**Stressor:** Livestock Grazing and Trampling (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Nearly all S. brevispinus potential habitat on BLM land is leased for grazing. The species range overlaps four BLM grazing allotments. Most of the area is grazed by sheep, either continuously or on a deferred rotation, with some cattle grazing on the western and eastern edges of S. brevispinus potential habitat. Livestock grazing results in S. brevispinus mortality when livestock trample individual cacti (Service 1990; Utah Natural Heritage Program 2006; BLM 2008; 72 FR 53215, September 18, 2007). Overgrazing—the continued heavy grazing beyond the recovery capacity of forage plants (Vallentine 1990)—by domestic livestock degrades western ecosystem functions and structures (Fleischner 1994). Overgrazing can facilitate the establishment of invasive species like cheatgrass (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. Invasive weeds (including Bromus tectorum and Halogeton glomeratus) are prevalent on BLM lands in the range of S. brevispinus cactus and less so on tribal lands where grazing has been concentrated in areas outside of suitable cactus habitat (72 FR 53214, September 18, 2007) (USFWS, 2010).

**Stressor:** Predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals

**Narrative:** Parasitism by the cactus-borer beetle (Moneilema semipunctatum) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 72 FR 53216, September 18, 2007). Parasitism is identified as a threat to Sclerocactus plants, however additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to S. brevispinus. Another source of mortality is lagomorph and rodent browsing. While there have been numerous observations of Sclerocactus being removed by desert cottontail rabbits (Sylvilagus audubonii) and unknown rodents (CNHP 2010b; BioLogic 2008; Clayton 2006), in subsequent years some of these plants have re-sprouted (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat (USFWS, 2010)

**Stressor:** Climate Change, Drought, and Impacts to the Vegetative Community (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Climate change is likely to affect long-term survival of native species, including S. brevispinus, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., such as persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of S. brevispinus. While the potential impacts of climate change could be serious, improved projections are needed to better understand this potential threat. S. brevispinus mortality due to drought is well documented (Service 1990; 72 FR 53217, September 18, 2007). Many dead S. brevispinus individuals were observed in the Uinta Basin after the severe drought of 1976 to 1977 (Service 1990). In addition, noxious weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM’s efforts to control noxious weeds and restore native vegetation, which is already difficult due to the extreme environment of the Uinta Basin (Service 1990; BLM 2005, 2008) (USFWS, 2010).

**Stressor:** Pesticides (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of indivduals
**Narrative:** S. brevispinus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as noxious weeds and insect pests (Service 1990). Individual cacti are likely to be directly affected by these chemicals, and indirectly by effects on pollinators or by movement of contaminated soils (Service 1990). However, specifics of the species' pollination biology are currently unquantified (USFWS, 2010)

**Stressor:** Vulnerability Related to Population Size and Distribution (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Extinction
**Narrative:** S. brevispinus' small population size and restricted distribution means the species is vulnerable to extinction by natural processes or human disturbance (Ellestrand and Elam 1993; Levin et al. 1996). For example, random events causing population fluctuations or population extirpations become a serious concern when the number of individuals or the geographic distribution of the species is very limited. Similarly, a single human-caused or natural environmental disturbance could destroy the entire population. The species' slow reproductive rate also increases the risk of effects of stochastic events as it is unlikely that the species will be able to rebound quickly (e.g., exhibit a high rate of population growth), even if environmental conditions improved after such an event. Other issues related to this factor include loss of genetic variability, which may reduce a species ability to respond to changing environmental conditions, (Godt et al. 1996) and inbreeding depression, which can decrease fertility and survival rates (Levin et al. 1996). No information exists to indicate that the species' range and population numbers have been significantly larger than they are currently, except for recent documented losses due to oil and gas development and illegal collection (USFWS, 2010).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** We are not aware of any city, county or state laws, ordinances or zoning that provide for protection or conservation of the S. brevispinus or its habitat. Removal, damage, or destruction of plants on private lands is  can be allowed through consultation with the Service. Conservation needs of S. brevispinus are addressed through interagency consultation (section 7 requirements) typically between the Service, BLM, and Bureau of Indian Affairs (BIA). Through this process, conservation measures are implemented on a project-by-project basis to minimize the loss of individual cacti from oil and gas activities. These measures include preconstruction cactus surveys and a required buffer around individual cacti. For example, the Castle Peak/Eightmile Flat Oil and Gas Expansion Project Final Environmental Impact Statement included conservation measures to specifically protect S. brevispinus and its habitat (BLM 2005). The BLM also has attempted to establish protected areas for S. brevispinus. The Pariette Wetlands Area of Critical Environmental Concern (ACEC) was established in 1994. The ACEC, intended to provide protection for this species, contains approximately 1,250 ha (3,086 ac) or 8 percent of the potential habitat of S. brevispinus. Management prescriptions for the ACEC state that the BLM will authorize no action in suitable habitat for threatened and endangered species if it would jeopardize the continued existence of the species or result in severe modification of the habitat (BLM 2008). Although the BLM Vernal Field Office Resource Management Plan designated the Pariette Wetlands ACEC as "no surface occupancy" for oil and gas development (BLM 2008), pre-existing lease rights still allow surface disturbance from oil and gas development within the ACEC (BLM 2005). As of November 2009, the ACEC contains one well for approximately every 30 ha (74 ac), with more development planned. The BLM is currently deferring approval of new wells and ancillary facilities located within the Pariette Wetlands ACEC until a master development plan is completed. In addition to the ACEC and project-specific protections such as cactus surveys, we need to establish consistent guidance and Resource

Management Plan designations that provide adequate regulatory mechanisms over the longer term to protect large portions of the range of the S. brevispinus (USFWS, 2010).

**Stressor:** Invasive and Noxious Weeds (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive species were not considered a threat to Sclerocactus at the time of the listing (44 FR 58868, October 11, 1979), but were identified as a threat in 2010 (USFWS 2010a, b). Increased disturbance from land use activities (oil and gas development, grazing, ORV use) and climate change are likely to facilitate the invasion and spread of invasive species such as cheatgrass (Bromus tectorum), halogeton (Halogeton glomeratus) and Russian thistle (Salsola tragus; Brooks 2003, Masters and Sheley 2001, Brooks and Pyke 2001). Invasive species compete with native plants for resources such as sunlight, soil nutrients, water, pollinators, and space. Invasive species alter plant composition and density in a variety of habitats from forested to desert ecosystems (Di Tomaso 1998, Young et al. 1998, Wilcove et al. 1998, Mack et al. 2000, Levine et al. 2003, Trombulak and Frissell 2000). This competition for resources may indirectly impact Sclerocactus by reducing individual fitness and reproduction, as well as the population by reducing seedling recruitment and population size (Di Tomaso 1998, Young et al. 1998, Wilcove et al. 1998, Mack et al. 2000, Levine et al. 2003, Trombulak and Frissell 2000). The most frequently observed invasive species occurring in Sclerocactus habitat are cheatgrass and flatspine stickseed (Lappula occidentalis; Hornbeck 2018). Monitoring plots recorded cheatgrass in 25 and 57 percent of plots for Pariette cactus and Uinta Basin hookless cactus, respectively (Hornbeck 2018). Flatspine stickseed was recorded in 35 and 22 percent of plots for Pariette cactus and Uinta Basin hookless cactus, respectively (Hornbeck 2018). (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5C

**Delisting Criteria:**
For Pariette cactus – All four core 2 areas have a stable or increasing growth trend (average lambda (λ) ≥ 0.095) over a minimum period of 10 consecutive years and predictive modeling (using data from a minimum of a 10-year monitoring period) indicates that the likelihood for long-term survival of the metapopulation is at least 95 percent over a 100-year period (USFWS, 2023).

For Pariette cactus – The metapopulation maintains a size distribution that contains individuals in all size classes over a 5-year minimum period and where the largest size class maintains a stasis rate no less than 0.85. Size classes for Pariette cactus are defined as: class 1:<19.7 mm; class 2: 19.7–40 mm; class 3: 40.1–75 mm; and class 4: >75 mm (Hornbeck 2020) (USFWS, 2023).

For Pariette cactus – Genetic diversity across the metapopulation is maintained at levels such that there is a high probability (95 percent) of two core 1 populations persisting over the long term (100 years) within each core 2 area (USFWS, 2023).

For Pariette cactus – Disturbance that contributes to the degradation and loss of habitat (e.g., roads, recreation, livestock) does not exceed established tolerance thresholds for each core 2 area (percent of habitat) (USFWS, 2023).

For Pariette cactus – Protected areas will be formally established by land managers for at least one genetically important population and at least one connectivity corridor (as identified using connectivity analysis) to provide long-term protection from anthropogenic threats. Methods may include but are not limited to ACECs, Resource Management Plan special designations, Tribal resolutions, conservation agreements, and conservation easements (USFWS, 2023).

**Recovery Actions:**

- Priority 1 Actions 1. Monitor two core 1 areas within each core 2 area for Pariette cactus and eight core 2 areas for Uinta Basin hookless cactus to evaluate short- and long-term population trends across the metapopulation and support predictive modeling. Monitoring should be conducted for a minimum of 10 years (Recovery Criteria 1 and 2). 2. Reduce impacts from livestock, feral horses, and herbivores on a landscape scale (in all subpopulations) through herd management, grazing rotations and rest, and habitat improvements (Recovery Criterion 1). 3. Develop disturbance tolerance thresholds for each core 2 area (Recovery Criterion 4). 4. Formalize conservation measures with partners to be implemented with, and prior to, all surface disturbing projects. Conservation measures may be documented in a memorandum of understanding, resource management plan, conservation agreement, recreation management plan, travel management plan, or similar document (Recovery Criteria 1, 2, 3, 4, and 5). 5. Restore disturbed areas within core habitat so that new surface disturbance is less than the tolerated threshold identified in Recovery Action 3 (Recovery Criteria 1, 2, and 3). 6. Resurvey subsampled areas (targeted and repeat) to update abundance and population estimates (Recovery Criteria 1, 2, 3, 4, and 5) (USFWS, 2023).
- Priority 2 Actions 7. Evaluate current genetic diversity across the species range to identify subpopulations at risk, those needing protections, and those of high importance (Recovery Criterion 2). 8. Conduct a connectivity analysis to identify important gene flow corridors (Recovery Criterion 2). 9. Restore or improve connectivity corridors between core 1 and core 2 areas that are important for maintaining gene flow across the species range and limit new surface disturbance in important existing connectivity corridors (Recovery Criteria 2 and 3) (USFWS, 2023).
- Priority 3 Actions 10. Update disturbance calculations on an annual basis for each core area (Recovery Criterion 3). 11. Develop a predictive model to evaluate the long-term trend and projected survival probability of each species under likely future scenarios, including climate change (Recovery Criteria 1, 2, 3, 4, and 5). 12. Reestablish Sclerocactus individuals on restored sites and monitor effectiveness (Recovery Criteria 1, 2, and 4). 13. Establish areas for permanent protections that provide the greatest benefit towards maintaining the redundancy, representation, and resiliency of the species (Recovery Criteria 1, 2, 3, and 5). 14. Develop and implement management plans for each protected area (Criterion 5) (USFWS, 2023).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that objective and quantifiable recovery criteria be established for each species, so that concrete goals can be established and progress towards recovery can be quantified. The recovery plans for these species should be completed in FY2021 as budgets allow. Based on ongoing actions and preliminary results, we recommend the continuation of the range-wide Sclerocactus monitoring program in order to track population trend over a long period of time. Management actions which result in preserving or improving intact habitat, population size class diversity, seedling recruitment, gene flow, and pollinator movement should be a high priority for both species. (USFWS, 2020)

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# SPECIES ACCOUNT: *Sclerocactus glaucus* (Colorado hookless Cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/11/1979; Mountain-Prairie Region (Region 6) (USFWS, 2016)

**Physical Description**

A squat, globular, spiny succulent. Each mature stem is 3-12 cm tall, 4-9 cm wide, although during the driest part of the year the stem may shrink to below ground-level. Central spines are straight (hookless). The plants are inconspicuous except when in flower (April-May), when showy, fragrant, pink to magenta flowers appear at the top of the stem. (NatureServe, 2015)

**Taxonomy**

The original listing rule for S. glaucus (44 FR 58868, October 11, 1979) included all hookless (straight central spines) Sclerocactus populations in western Colorado and northeastern Utah, and referred to them as S. glaucus per Benson (1966, pp. 50-57; 1982, pp. 728-729). Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993; Welsh et al. 2003), and a reevaluation of the morphological characteristics of S. glaucus have led to separating this species into three distinct species: S. brevispinus, S. glaucus, and S. wetlandicus (Hochstätter 1993; Heil and Porter 2004). The Flora of North America recognizes 15 species in the genus Sclerocactus, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between S. brevispinus and S. wetlandicus, but infer S. glaucus is more closely related to S. parviflorus (Devil's claw cactus) and S. whipplei (Whipple's fishhook cactus). The common name for S. glaucus was changed to Colorado hookless cactus as the species is endemic to western Colorado. S. wetlandicus is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. S. brevispinus is now known as the Pariette cactus as it is limited to the Pariette Draw of the Central Uinta Basin. (USFWS, 2010)

**Current Range**

Colorado hookless cactus is an endemic plant found in Delta, Montrose, Mesa, and Garfield Counties, Colorado. There are two population centers of Colorado hookless cactus: (1) on alluvial river terraces of the Gunnison River from near Delta, Colorado, to southern Mesa County, Colorado; and (2) on alluvial river terraces of the Colorado River and in the Plateau and Roan Creek drainages in the vicinity of DeBeque, Colorado (Service 1990). (USFWS, 2010)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Predominately sexual (outcrossing) but can reproduce asexually (NatureServe, 2015)

**Lifespan**

Adult: 10-20 years (NatureServe, 2010)

**Breeding Season**

Adult: April to May (NatureServe, 2015)

**Reproduction Narrative**

Adult: Reproduction is predominately sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantely outcrossing but is marginally self-compatible. Although no long-term demographic data is available, field observations suggest that plants may live for 10-20 years in good conditions (Ellen Mayo, Peggy Lyon pers. comm.) Population size may vary widely between years (Jim Ferguson, pers. comm.). Plants are typically sparsely distributed even in larger populations. Stems may fluctuate in size according to seasonal moisture availability, shrinking below the soil surface in dry times. Predation by a cactus borer beetle has been observed in Colorado populations, and may be very heavy in a localized area. Some herbivory by rodents has also been observed. (NatureServe, 2015)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Desert, forest/woodland, shrubland/chaparral, woodland - conifer (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs at elevations between 1200 and 2000 m (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: The Colorado hookless catcus is found on exposed, gravel-covered, clay hills, saltbush or sagebrush flats, or pinyon-juniper woodlands at elevations from 1400 to 2000 m (Flora of North America Editorial Committee 2003). Populations occur primarily on alluvial benches along the Colorado and Gunnison Rivers and their tributaries. Sclerocactus glaucus generally occurs on gravelly, or rocky surfaces on river terrace deposits and lower mesa slopes. Exposures vary, but S. glaucus is more abundant on south-facing slopes. Soils are usually coarse, gravelly river alluvium above the river flood plains usually consisting of Mancos shale with volcanic cobbles and pebbles on the surface. Elevations range from 1200-2000 m. Associated vegetation is typically desert scrub dominated by shadscale (Atriplex confertifolia), galleta (Hilaria jamesii), black-sage (Artemisia nova), and Indian rice grass (Stipa hymenoides). Other important species include two similar spherical or cylindrical cactus species, strawberry hedgehog cactus ( Echinocereus triglochidiatus var. melanacanthus) and Simpson's pincushion cactus (Pediocactus simpsonii). Other important species in the plant community include the prickly pear cactus (Opuntia polyacantha), winterfat (Krascheninnikovia lanata), yucca (Yucca harrimaniae), snakeweed (Gutierrezia sarothrae), low rabbitbrush (Chrysothamnus viscidiflorus), sand dropseed (Sporobolus cryptandrus), and Salina wildrye (Elymus salinus) (USFWS 1990, Scheck 1994). Fire is not typically characteristic of S. glaucus habitat, but areas with large infestations of cheatgrass (Bromus tectorum) may build up sufficient fuel to carry fire into S. glaucus populations. (NatureServe, 2015). S. glaucus and S. dawsonii are endemic cactus species found in the Colorado and Gunnison River basins and their tributary canyons in Garfield, Mesa, Montrose, and Delta Counties in western Colorado. The species occur on alluvial benches and colluvial slopes from 4,500 to 7,200 feet (1,372 to 2,195 meters) in semi-arid high elevation desert. S. glaucus occurs in eight analytical units (AUs) in a range that extends from the Grand Valley, through the high desert at the foot of the Grand Mesa, and along the alluvial terraces of the Gunnison River and the Dominguez and Escalante Creek drainages to near Montrose. S. dawsonii occurs in two AUs along the Colorado River from DeBeque downstream toward the Grand Valley and along the Roan and Plateau Creek drainages (USFWS, 2022).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of Sclerocactus glaucus. (NatureServe, 2015)

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe, 2015)

**Resiliency:**

To be resilient, AUs of both species require survivorship and recruitment at rates that are able to sustain AUs with pollinator connectivity between individuals and clusters of plants within the AU. Resilient AUs also contain enough individuals across each life stage (seed, seedling, and mature reproductive adult) to bounce back after experiencing environmental stressors such as intermediate disturbance, occasional drought, or grazing. Finally, individuals in both species of Colorado hookless cactus need certain habitat factors for resiliency. These include shallow exposed sandy or shale soils of sedimentary parent material or gravelly deposits of river alluvium; a semi-arid, high elevation desert climate (1,372-2,195 m) with 8-12 inches rain per year; and a period of deep cold during winter months to facilitate germination the following spring. (USFWS, 2022)

**Representation:**

Individuals and AUs inhabiting diverse ecological settings and exhibiting genetic or phenological variation add to the level of representation across the species' range. The greater diversity observed in Colorado hookless cactus genetics, habitats, and morphology, the more likely it is to be able to adapt to change over time. (USFWS, 2022)

**Redundancy:**

Colorado hookless cactus redundancy is influenced by the number of AUs across the landscape. More AUs across the range of Colorado hookless cactus increase the species' ability to withstand catastrophic events. (USFWS, 2022)

**Population Growth Rate:**

Unknown (NatureServe, 2015)

**Number of Populations:**

98 (USFWS, 2010). 8 AUs (USFWS, 2022)

**Population Size:**

>= 103,086 (USFWS, 2022)

**Population Narrative:**

The species has been documented at 98 element occurrences (EOs) totaling approximately 13,300 individuals (CNHP 2010b). Forty-two of the EOs have not been observed in over 20 years. Over 6,000 additional individuals were located recently in field surveys for a proposed electric transmission line and a proposed oil and gas wastewater evaporation facility north of Delta, Colorado (Bio-Logic 2008; 2009). These newly discovered individuals have not yet been incorporated into the CNHP database. Therefore, by combining the new survey data and the CNHP data, we estimate the total known population of Colorado hookless cactus at over 19,000 plants. (USFWS, 2010). Currently, S. dawsonii has a minimum of 31,867 plants distributed across two highly resilient AUs with a high survival rate and moderate to high habitat conditions across the range of the species. S. glaucus currently has a minimum of 103,086 plants distributed across eight AUs. Seven of the eight AUs are highly resilient; one is ranked moderate. Across their limited ranges, both species of Colorado hookless cactus are relatively abundant, which contribute to the high levels of resiliency in all but one AU. Redundancy for narrow endemic species is inherently limited; however, S. glaucus plants are distributed broadly across the range of the species in eight AUs, providing redundancy throughout its relatively small geographic range. With only two AUs located within a smaller range than S. glaucus, redundancy of S. dawsonii is much lower than that of S. glaucus. S. glaucus's relatively broad distribution and multiple highly resilient AUs make it better able to withstand catastrophic events than S. dawsonii. Representation is comparable among S. glaucus and S. dawsonii (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Mineral and energy development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 1990 Recovery Plan identified threats associated with mineral and energy development including: oil and gas, oil shale and tar sands, sand and gravel quarrying, gold dredging, and building stone collecting and quarrying. A gravel mining project proposed near Whitewater, Colorado, poses a threat to several Colorado hookless cactus individuals (BLM 2010). The BLM recently closed an area where recreational gold panners were causing disturbance in close proximity to a Colorado hookless cactus occurrence (BLM 2009b). Oil and gas development remains a meaningful factor in the long-term conservation of the Colorado hookless cactus. Thirty-six percent of the federally-owned potential habitat approximately 164,000 ac (66,000 ha) is leased for oil and gas development (Service 2010b). Increased surface disturbance from wells, roads and pipelines for oil and gas projects can result in the following impacts to S. and habitat. Oil and gas development fragments and destroys S. habitat (BLM 2005, 2008a). Each well disturbs approximately 1.5 ac (0.6 ha) of surface area (74 FR 47112, September 15, 2009). Increased erosion, soil compaction, and sedimentation can kill cacti (BLM 2005). Cactus seeds can be buried and lost due to erosion runoff from well-field facilities (BLM 2005). Increased surface disturbance increases airborne dust. Dust accumulation on cacti increases tissue temperature and reduces photosynthesis, thus decreasing plant growth, vigor,

and water use efficiency (Farmer 1993; Sharifi et al. 1997). Dust effects can extend up to 300 m from roads (Everett 1980). Energy development requires the addition of access roads in previously undeveloped areas. In most cases, these access roads are open to the public. The ORV trail use increases erosion, fugitive dust, soil compaction, sedimentation, and can crush cactus (Service 1990; BLM 2008a). Human access can result in illegal collection and the direct loss of individual plants (Service 1990; BLM 2005). Oil and gas development increases weed invasions because of the associated surface disturbance. Increased invasive weeds alter the ecological characteristics of cactus habitat, making it less suitable for the species (Service 1990; BLM 2008a).

**Stressor:** Utility corridors (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A BLM and Department of Energy designated Westwide Energy Corridor covers 70,142 ac (28,385 ha) of BLM land that is potential habitat for Colorado hookless cactus (Service 2010b; BLM 2008b). The BLM identified preferred corridors to limit the proliferation of additional rights-of-way across the landscape, but utilities are not limited to these corridors (BLM 2008b). Twenty-nine of the species’ 98 occurrences are at least partially located within this energy corridor (Service 2010b; BLM 2008b). Specific pipeline and transmission line routes within the energy corridor are not yet identified. The TransColorado (TransCO) gas pipeline resides in this corridor. Many of the 29 aforementioned occurrences were discovered during surveys for this project. The TransCO project resulted in transplantation of approximately 1,200 Colorado hookless cactus individuals. Monitoring documented a 19-percent mortality rate for the 129 monitored individuals between 1999 and 2003 (Bio-Logic 2008). Surveys for a new powerline north of Delta, Colorado (not in the designated energy corridor), located approximately 5,200 Colorado hookless cactus individuals (Bio-Logic 2008). Up to 100 individuals may be transplanted or destroyed during construction of this powerline in 2010 (Bio-Logic 2008). (USFWS, 2010)

**Stressor:** Invasive species (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive weeds, including Bromus tectorum (cheatgrass) and Halogeton glomeratus (halogeton), are prevalent on BLM and private lands within the range of Colorado hookless cactus (CNHP 2010b). Invasive weeds alter the ecological characteristics of cactus habitat, making it less suitable for the species (Service 1990; BLM 2008a). In addition, invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Several EO records include cheatgrass invasion as a threat, and BLM attributes downward trend at several locations to cheatgrass invasion (CNHP 2010b; BLM 2009a). (USFWS, 2010)

**Stressor:** Off road vehicle use (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Despite ORV use being common within Colorado hookless cactus habitat, there have been few documented impacts to the plants. Observers documented ORV use as a threat to 3 of the 98 EOs (CNHP 2010b). Additionally, illegal off road driving damaged Colorado hookless

cactus individuals during construction of the Collbran pipeline (WestWater Engineering 2009). The ORV use is expected to increase along with expected human population increases in the region in which Colorado hookless cactus is native and with increasing popularity and availability of improved ORVs. This is expected to result in an increase in damage to Colorado hookless cactus individuals and habitat (Service 1990). (USFWS, 2010)

**Stressor:** Water development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 1990 Recovery Plan identified water development as a threat to the species. It is likely that reservoir and irrigation canal development have impacted Colorado hookless cactus occurrences in the past; however, we have no documentation of those impacts. Two water reservoir projects known as Roan Creek and Sulphur Gulch have been proposed within potential and occupied habitat of Colorado hookless cactus. These potential reservoirs could permanently destroy plants and their habitat through project construction and inundation. After evaluation of numerous alternatives, the Roan Creek and Sulphur Gulch projects are no longer being considered (Bray and Drager pers. comm. 2008; Grand River Consulting Corporation 2009). Since the proposals have been withdrawn, these threats are not imminent. (USFWS, 2010)

**Stressor:** Collection (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The original listing of the Uinta Basin hookless cactus complex concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductively fit population. We are not aware of illegal removal of Sclerocactus in Colorado prior to 2009. Three Colorado hookless cactus individuals were removed illegally in 2009 from sites proposed for a natural gas pipeline and a sewer pipeline in Mesa County, Colorado (Service 2010a; Glenne 2009). It did not appear that these plants were removed by collectors, but rather these were acts of vandalism. Additional damage to cacti occurred during project construction on the same natural gas pipeline (WestWater Engineering 2009). These incidents show that additional development increases risk to cacti of vandalism and removal by increasing human presence in areas previously rarely visited by humans. (USFWS, 2010)

**Stressor:** Livestock grazing and trampling (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Of the 450,000 ac (182,000 ha) of Colorado hookless cactus potential habitat on Federal lands, approximately 94 percent, 424,000 ac (172,000 ha) falls within grazing allotments. Moderate to heavy domestic livestock grazing has been observed to cause physical damage to Sclerocactus plants through trampling, but we have no evidence to suggest that cattle browse on individual Sclerocactus plants (Service 1990). A study on another federally listed cactus, S. wrightiae, found that cacti density increased more rapidly in a fenced plot excluded from cattle grazing than in an unfenced plot with a reduced cattle stocking rate (Clark and Clark 2007). Overgrazing (the continued heavy grazing beyond the recovery capacity of forage plants) by

domestic livestock can have a negative impact on North American xeric ecosystems (Jones 2000; Vallentine 1990). For example, overgrazing can facilitate the establishment of invasive species like Bromus tectorum (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. (USFWS, 2010)

**Stressor:** Predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Another source of mortality is lagomorph and rodent browsing on Colorado hookless cactus. While there have been numerous observations of S. glaucus individuals being removed by desert cottontail rabbits (Sylvilagus audubonii) and unknown rodents (CNHP 2010b; BioLogic 2008; Clayton 2006), some of these plants have re-sprouted in subsequent years (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat. Parasitism by the cactus-borer beetle (Moneilema semipunctatum) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 74 FR 47112, September 15, 2009). Additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to Colorado hookless cactus. (USFWS, 2010)

**Stressor:** Herbicides and pesticides (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Colorado hookless cactus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as cheatgrass and crop harming insects (Service 1990). Individual cacti are likely to be directly affected by herbicide use, and indirectly by effects of pesticides on pollinators (Service 1990). However, we cannot fully assess the magnitude of this threat, since the specific species that pollinate Colorado hookless cactus are currently unknown. (USFWS, 2010)

**Stressor:** Hybridizations (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Extinction due to hybridization, both natural and human influenced, can be a major concern for rare and endangered species (Denver Botanic Gardens 2009b). Colorado hookless cactus may hybridize with S. parviflorus (Heil & Porter 1987; Woodruff 2009; CNHP 2010b). The extent to which hybridization is occurring is unknown. Genetic research investigating this issue is essential for planning management and recovery efforts. The Denver Botanic Gardens has begun collecting floral tissue to examine the population genetic structure within and among the two population centers of Colorado hookless cactus and investigate the potential threat of introgression with S. parviflorus (Denver Botanic Gardens 2009b). (USFWS, 2010)

**Stressor:** Climate change, drought, and impacts to the vegetative community (USFWS, 2010)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Climate change is likely to affect long-term survival of native species, including Sclerocactus, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of Colorado hookless cactus. While the potential impacts of climate change could be significant, improved localized projections are needed to better understand this potential threat. In addition, invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM’s efforts to control invasive weeds and restore native vegetation, which is already difficult due to the extreme environment of the Colorado and Gunnison River basins (Service 1990; BLM 2005, 2008a). (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

**Delisting Criteria:**
Delisting criteria are not available.

**Recovery Actions:**
- Completion of a comprehensive survey throughout the species’ range. (USFWS, 2010)
- Surveys also should more accurately delineate the Colorado hookless cactus range relative to other Sclerocactus species. (USFWS, 2010)
- Locate possible population connectivity corridors. (USFWS, 2010)
- Continue ongoing monitoring efforts and expand monitoring to include a larger and more representative sample of occupied sites. (USFWS, 2010)
- Identify sites in urgent need of habitat protection, set protection priorities, and implement protective measures. In the long run, land management agencies should establish formal land management designations to provide for long-term protection of important populations and habitat. (USFWS, 2010)
- Oil and gas leasing and other mineral extraction activities should avoid occupied sites and other important habitat. (USFWS, 2010)
- Develop and implement standard conservation measures to minimize future project and use impacts. (USFWS, 2010)
- Coordinate with land management agencies, project proponents, and other partners early in the planning process to limit direct and indirect impacts of planned activities. (USFWS, 2010)

- Prevent the collection of Colorado hookless cactus plants from natural populations. (USFWS, 2010)
- Resolve the taxonomic status of Colorado hookless cactus regarding the species relationship with S. parviflorus. Secondarily, this study would assess genetic differences between Colorado hookless cactus populations. (USFWS, 2010)
- Continue research into Colorado hookless cactus life history and ecology, including pollinators. (USFWS, 2010)
- Study population dynamics and conduct a population viability analysis. (USFWS, 2010)
- Encourage investigations that project Sclerocactus species' vulnerability and response to climate change. (USFWS, 2010)
- Improve our understanding of livestock and native (e.g., rodent) grazing impacts. (USFWS, 2010)
- Monitor cactus-borer beetle (Moneilema semipunctatum) infestations, and study the relationship of episodic infestations with drought and other environmental factors. (USFWS, 2010)
- Monitor changes in invasive species prevalence and impacts on Colorado hookless cactus. Additionally, continue to explore approaches to minimize the risk posed by invasives and associated remediation actions. (USFWS, 2010)
- Make a final determination on the proposed the taxonomic revision splitting Sclerocactus glaucus into S. brevispinus, S. glaucus, and S. wetlandicus. We expect to make a final determination on this proposal in 2008. (USFWS, 2008)
- Issue a proposed and final rulemaking to reclassify S. brevispinus from threatened to endangered as described in our recent 12-month finding (72 FR 53211, September 18, 2007). (USFWS, 2008)
- Develop a recovery plan for each of the three species. As required by Section 4(f)(1)(B), each recovery plan should incorporate: (i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal. (USFWS, 2008)
- Conduct range-wide inventories for each species. Once completed, continue and improve population monitoring for each species. (USFWS, 2008)

***Conservation Measures and Best Management Practices:***

- STATUS RECOMMENDATION Standard for Review Section 4 of the Act (16 U.S.C. Section 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of an "endangered species" or a "threatened species" because of any of the following factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. (USFWS, 2021)

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# SPECIES ACCOUNT: *Sclerocactus mesae-verdae* (Mesa Verde cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/29/1979; Southwest Region (Region 2) (USFWS, 2016)

**Physical Description**

The Mesa Verde cactus stems are usually singular, globose, 3.2-6.5 cm tall (1.5 - 3 in) and of equal diameter; central spine 0 (possibly 1-4); radial spines 8-11, 6-13 mm long (1/4-1/2 in), white, tan, straw or gray; flowers 2 cm in diameter (3/4 in), cream to yellow; fruit green, becoming brown with age and splitting open horizontally; seeds black. In late April a yellow or cream-colored flower blooms on top of the stem. (USFWS, 1984)

**Taxonomy**

Sclerocactus mesae-verdae and S. wrightiae have several morphological features in common: stem size, shape and color; flower shape and color; fruit dehiscence (not bearing scale leaves); and the ability to retract into the soil during periods of drought. S. mesae-verdae has 0-1 central spines, 8-11 radial spines, cream to yellow flowers with no fragrance, brownish-black seeds, while S. wrightiae has 4-6 central spines, 5-10 radial spines, cream to pink flowers with fragrance, and black seeds. (USFWS, 1984)

**Current Range**

Occurs only in parts of Montezuma County, Colorado and San Juan County, New Mexico. Mostly on Navajo Indian Reservation lands (Roth, pers. comm., 1998). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual and asexual (USFWS, 2010)

**Lifespan**

Adult: ~50 years (USFWS, 2023)

**Dependency on Other Individuals or Species**

Adult: Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Other common visitors included pleasing fungus beetles (Tritoma sp.) and blister beetles (Epicauta sp.), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993). (USFWS, 2010)

**Breeding Season**

Adult: Late April to early May (USFWS, 2010)

**Key Resources Needed for Breeding**

Adult: Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). (USFWS, 2010)

**Reproduction Narrative**

Adult: Sclerocactus mesae-verdae is a perennial desert plant that grows slowly and has a lifespan of approximately 20 years (Colorado Natural Areas Program 2005). Stems begin producing flowers when they are about 2 cm (0.8 in) in diameter or about 8 years old and begin to flower each year after reaching 4 cm (1.6 in) in diameter (New Mexico State Forestry Division 2007). Flowers are diurnal, bloom from late April into early May, and open daily for up to five days (Heil and Porter 1994). Flowers possess both male and female organs (hermaphroditic) indicating self-compatibility, yet Heil and Porter (1994) suggest that self-fertilization rarely is found in the genus Sclerocactus. Tepedino (1998) found that a single plant can self-fertilize (selfing) using pollen from another flower on the same plant (geitonogamy) and produce viable seed, but not pollen from the same flower (autogamy). However, 50 percent less seed is produced from self-compatible fertilization when compared to the pollen donor coming from a flower on a nearby plant (xenogamy or outcrossing) (Tepedino 1998). Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Other common visitors included pleasing fungus beetles (Tritoma sp.) and blister beetles (Epicauta sp.), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993). Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). Seed dispersal distance and seed bank sampling found a total seed load around mature plants averaging 200 seeds within a 1 meter (m) (3.3 feet [ft]) radius with 80 percent of the seeds 0 - 3 cm (0 - 1 in) deep in the soil (Cully et al. 1993). Mesa Verde cactus, or Whoosh Diikoozih (O'Kane et al. 2022, p. 5), is a perennial desert plant that grows slowly and has an estimated lifespan of at least 50 years (Coles et al. 2012, p. 313). Mesa Verde cactus can reach maturity within 2 to 3 years and can reach a reproductive size in 7 to 11 years (Coles et al. 2012, p. 313). The Navajo Natural Heritage Program found during monitoring that stems lived an average of 4.33 years, however 27 stems (out of 270 stems) survived the entire study (2008-2019; 11 years) (USFWS, 2023)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Desert (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Open sunny areas (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Restricted to dry exposed hills and mesas at elevations about 1,400 to 2,000 m; sparsely vegetated areas (USFWS, 2010; NatureServe, 2015)

**Environmental Specificity**

Adult: Medium (USFWS, 2010)

**Tolerance Ranges/Thresholds**

Adult: Moderate (USFWS, 2010)

**Habitat Narrative**

Adult: Sclerocactus mesae-verdae are restricted to sparsely vegetated badlands of clay loam soils derived from upper Cretaceous Mancos shale in Colorado, and Mancos and Fruitland shale in New Mexico (Service 1984). Populations are located in a narrow strip of land between Cortez, Colorado, and Sheep Springs, New Mexico, at elevations ranging from 1,400 to 2,000 m (4,600 - 6,560 ft) (Heil and Porter 1994; Coles and Naumann 2003). These formations erode easily, forming low, rolling hills where plants are found on hilltops and benches, but less so in basins or swales (Cully et al. 1993; Coles and Naumann 2003). The soils are sodic (high alkalinity; pH 7.5 to 8), gypsiferous (poor permeability), and have shrink-swell tendencies which make harsh sites for plant growth (Potter et al. 1985). However, during severe hot or cold dry periods, individual plants shrink and retract back into soils which can minimize desiccation or dehydration (Heil and Porter 1994). Colorado State University soil lab results on Colorado Natural Areas Program plots (2001) revealed clay and silty clay loams in texture, with low water permeability. Sodium, calcium, selenium and iron levels are elevated, while organic matter, phosphate and nitrate levels are low. Cracks in the clay soil, where the seeds fall and may germinate, are apparently an important part of the plant's microhabitat. Soils are typically high in selenite. Vegetative associates, though low in total percent ground cover (5 to 18 percent), include Atriplex cuneata (valley saltbush) and A. corrugata (mat saltbush) in New Mexico, and A. corrugata, A. confertifolia (shadscale saltbush), A. gardneri (Gardner’s saltbush), and Artemisia spinescens (bud sagebrush) in Colorado (Cully et al. 1993; Coles and Naumann 2003). In both states, A. corrugata was consistently found to be the dominant shrub.(USFWS, 2010; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal**

Adult: Moderate (USFWS, 2010)

**Dispersal/Migration Narrative**

Adult: Harvester ants (Pogonomyrmex sp.) and erosional processes (rain) are the most effective short-range seed dispersers; whereas, wind may be more important to long-range dispersal (Cully et al. 1993; Rojas-Arechiga and Vasquez-Yanes 2000). Seed predation is well known in desert areas with frugivores (fruit eaters) being another type of important dispersal agent. Mainly rodents, but also birds, lizards, and some mammals prey on fruits and seeds (Rojas-Arechiga and Vasquez-Yanes 2000). No long-range dispersal was observed by rodents or birds for this species (Cully et al. 1993; Colorado Natural Areas Program 2005; Navajo Natural Heritage Program 2005). (USFWS, 2010)

***Population Information and Trends***

**Population Trends:**

Long-term trends are unknown but short-term trends indicate a decline of 10-30% (NatureServe, 2015)

**Population Growth Rate:**
Slow growth and reproduce success rate (NatureServe, 2015)

**Number of Populations:**
78 (NatureServe, 2015)

**Population Size:**
10,000 individuals (NatureServe, 2015)

**Population Narrative:**
Slow growth and low reproductive success rate; the taking of a few plants can deplete/extirpate a population. There is insufficient data to characterize long-term population trends but short-term trends indicate a decline of 10-30%. Approximately 2000 individuals have been documented in element occurrence records (CNHP 2012, NHNM 2003), although the species is estimated to be represented by as many as 10,000 individuals (Coles 2003). A total of 78 occurrences have been documented, 22 in Colorado and 56 in New Mexico (CNHP 2012, NHNM 2003). Twenty of the occurrences report less than 10 individuals each. (NatureServe, 2015). Mesa Verde cactus is not distributed continuously throughout its range, distribution is instead sporadic and widely scattered. Mesa Verde cactus density within populations is low, rarely exceeding one plant per 10 square meters (108 square feet) (Coles et al. 2012, p. 312). Of the known Mesa Verde cactus populations, at least 80 percent of these occur on Navajo Nation lands, 15 percent on Ute Mountain Ute lands, and 5 percent on small blocks of Bureau of Land Management and New Mexico State trust lands (NMSFD 2020b, p. 2). Mesa Verde cactus are now known to occupy private land (BOR 2022, p. 18). At this time, not all potentially suitable habitat for Mesa Verde cactus has been surveyed (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Highway construction and right-of-ways for transmission lines (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Navajo Nation and BLM have consulted with the Service for various projects that have taken place or are planned to occur in areas with occupied or suitable habitat for S. mesae-verdae. We provide a list of consultations in order to convey the number and diversity of projects and to acknowledge the continuing compliance of the Navajo Nation and BLM with accounting for rare species. In each case, however, after the Service provided non-jeopardy opinions, we did not receive any further information regarding implementation of conservation measures, including post-construction surveys or progress reports. To ensure that the conservation measures are implemented and effective, and to apply adaptive management, if needed, to modify measures to assist the cactus, providing documentation of the outcome of these projects and other monitoring data would be very beneficial to the Service. By sharing information about the effects of projects, all parties managing S. mesae-verdae can be informed of what conditions are most favorable for this cactus and what conservation measures are the most worthwhile for promoting this species' recovery and moving toward delisting. There is a

need for a S. mesae-verdae multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. (USFWS, 2010)

**Stressor:** Off-highway vehicles (OHVs) (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 1984 recovery plan correctly anticipated that OHV use would be one of the greatest human-caused threats to S. mesae-verdae. The use of OHVs appears to have increased within the Navajo Nation (Roth 2009, pers. comm.) and on BLM lands ((Jamison 2009, pers. comm.). This increase is most likely due to the recent energy boom and the resultant population boom within San Juan County; a 55 percent increase in population from 1980 to 2006 (http://wrdc.usu.edu/htm/publications/). National all-terrain and off-highway vehicles retail sales from 1993-2003 show a dramatic increase from 2,920 total vehicles sold in 1993 to a total of 8,010 vehicles sold by 2003 (Cordell et al. 2005). However, the perception of increased OHV traffic may be more of an issue of unmanaged/unregulated use where one vehicle could cause extensive and severe habitat damage with one trip through closed areas. When a vehicle runs over a cactus, the growing tip is often damaged resulting in a failure to flower and set seed as well as an increased vulnerability to desiccation, herbivory, and pathogens. Cacti can also be directly uprooted or irreversibly damaged from OHVs or any other form of forceful contact. In addition to these direct impacts to the cactus, indirect effects from OHV riding also occur such as damage or destruction of annual and perennial plants, destruction of fragile soil crusts, soil erosion and compaction, alteration of drainage patterns, formation of dust, and proliferation of weeds (Brooks 2009; Lei 2009). Erosion and denuding of plants on dry soils from unauthorized OHV use changes soil properties and alters the hydrological dynamics of an area, with impacts spanning from the microhabitat to the landscape scale. These factors increase run-off and decrease the infiltration of precipitation into soils, further diminishing water storage and accessibility to plant roots. Off-highway vehicle activity can also disturb fragile cyanobacterial-lichen soil crusts, a dominant source of nitrogen in desert ecosystems (Belnap 1996). Belnap (1996) showed that anthropogenic surface disturbances may have serious implications for nitrogen budgets in cold-desert ecosystems similar to those occupied by S. mesae-verdae. Soil crusts also appear to be an important source of water for plants, as crusts were shown to have 53 percent greater volumetric water content than bare soils during the late fall when winter annuals are becoming established (DeFalco et al. 2001). Once the soil crusts are disturbed, non-native plants may colonize, become established, and outcompete native perennial and annual plant species (DeFalco et al. 2001). Surface disturbance from OHV activity can cause erosion and large amounts of dust to be discharged into the air. Recent studies addressing surface dust impacts on gas exchanges of desert shrubs showed that plants encrusted by dust have reduced photosynthesis and decreased water-use efficiency, which may decrease primary production during seasons when photosynthesis occurs (Wijayratne et al. 2005; Sharifi et al. 1997). Sharifi et al. (1997) also showed reduction in maximum leaf conductance, transpiration, and water-use efficiency due to dust. These effects may impact desert plants including S. mesae-verdae. Impacts from constant OHV use, causing soil, vegetation, and hydrological disturbances, have the capacity to compound over time, particularly if the source of OHV impacts is located high in a drainage (Brooks and Lair 2005). Repeated OHV trail use leads to new routes that are not included in road databases (Brooks and Lair 2009). As a result, continual unauthorized OHV use, especially off-trail riding, can create conditions less and less supportive for a habitat specialist such as this cactus species. Furthermore, reduced moisture availability and ground cover from

OHV use can interact with other variables such as climate change or grazing, exacerbating drying conditions an already arid system. (USFWS, 2010)

**Stressor:** Coal mining (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** About 90 percent of known S. mesae-verdae habitat occurs in areas that lack coal reserves (Parker et al. 1977). The 1984 recovery plan reported that no coal mining was being actively pursued within occupied habitat, although several strip mining operations were within a few miles of the Waterflow cactus population (Service 1984). This cactus population was the only one known growing on the coal-bearing Fruitland formation (Service 1984). We are not aware of any effects resulting from coal mining on this species (Sivinski 2000). Thus, we believe that coal mining is not currently a threat and is not likely to threaten the species in the foreseeable future. (USFWS, 2010)

**Stressor:** Oil and gas exploration and production (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** About 70 percent of the known occupied S. mesae-verdae habitat is located on Navajo Nation lands. Navajo Nation lands contain significant deposits of coal, oil, and natural gas. Development of energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). The Fruitland Coal formation of the San Juan Basin is the largest coal bed methane producer in the United States (Energy, Minerals, and Natural Resources Department 2008). These resources occur subsurface in ancient marine shale layers, primarily Fruitland and Mancos layers, which coincide with S. mesae-verdae habitat. Nearly all known cactus habitat has the potential to be affected by natural gas or oil exploration and development. Another mineral, a decomposed type of coal (humate), is also found under much of S. mesae-verdae habitat (Colorado Natural Areas Program 2004). Humate is used as a soil conditioner and additive to drilling mud which increases the potential for development. About 12.1 billion tons of humate occur within the San Juan Basin (McLemore et al. 2002). Ground disturbing impacts from these activities include the construction and maintenance of pipelines, power lines, and associated roads; the total clearing of all vegetation on an average of three acres for every oil or gas well pad and associated facilities; and associated commercial and residential development. These activities lead to long-term degradation, fragmentation, or loss of habitat, with impacts to S. mesae-verdae similar to those described above in the OHV section. Most S. mesae-verdae habitat occurs on the Mancos Formation, with the Rattlesnake, Shiprock-Gallup, Horseshoe-Gallup, and Hogback oil fields located within high quality habitat. Destruction of cactus habitat from these oil fields appears to be extensive (Roth 2008, pers. comm.); however, data quantifying the size of each oil field, number of cactus mortalities, and leasing of other areas for associated activities are not available. (USFWS, 2010)

**Stressor:** Commercial and residential development (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Commercial and residential development threatens S. mesae-verdae on private and Tribal lands (Service 2009). Since the species was listed, cactus habitat has been increasingly impacted from urban development on Navajo Nation lands (Navajo Natural Heritage Program 2004). Urban development is not allowed within a BLM ACEC or on New Mexico State trust lands. The status of urban development on Ute Mountain Ute lands regarding this cactus is unknown at this time. Impacts from urban development include habitat loss, fragmentation, and degradation, along with other factors relating to soil, vegetation, and hydrologic disturbances described in more detail in the off-highway vehicles section above. These impacts not only directly damage cacti, but also can make occupied and potentially usable habitat inhospitable to S. mesae-verdae and result in the decline of individuals and populations. Urban development, including homes, roads, power lines, pipelines, and waterlines; increased recreational activities, including use of OHVs; and commercial facilities have expanded in the proximity of Shiprock. In an effort to off-set the Navajo fairground project interfacing with the cactus, the Northern Navajo Fairground Conservation Area was established in 2001 to use for transplanting cacti that otherwise would be destroyed by the construction of the fairground. However, it is unknown at this time if signs and fences are in place to protect this area. (USFWS, 2010)

**Stressor:** Livestock grazing and trampling (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The 1984 Recovery Plan (Service) stated that livestock grazing was not believed to be a significant threat. Since that time, nearly all monitoring has documented disturbance of S. mesae-verdae by livestock. Livestock grazing occurs throughout the range of the cactus, and impacts from trampling, such as uprooted cacti, partially or entirely crushed cacti, and soil disturbance immediately adjacent to cactus individuals are regularly observed (Ecosphere Environmental Services 1985). Cattle have also been observed eating S. mesae-verdae (Service 1984; Ecosphere Environmental Services 1985). Livestock grazing continues to be permitted by the BLM within the Hogback ACEC (Bureau of Land Management 2003b). Navajo Nation staff noted heavy sheep and cattle grazing at the Sheep Springs population that historically supported S. mesae-verdae prior to 2004 (Navajo Natural Heritage Program 2004), but now appears to be extirpated (Roth 2008, pers. comm.). Three additional occupied areas on Tribal land were observed to have extensive livestock damage (Navajo Natural Heritage Program 2004). In Colorado, livestock trampling was also documented and believed to be the primary source of cactus mortality in 2005 (Colorado Natural Areas Program 2005). The 1984 Recovery Plan reported that when livestock are fenced in cactus habitat, trampling of the species could occur. High intensity grazing associated with fenced private or Tribal residences is likely to result in the permanent loss of cacti through trampling and soil compaction (Service 2009). On larger fenced acres, ranchers drive their trucks and OHVs off-road, tracking or herding their livestock (Jamison 2009, pers. comm.). Likewise, during capture of feral horse herds on the Navajo Nation, soils have become compacted within S. mesae-verdae habitat (Service 2009). Based on the increase in habitat degradation due to livestock trampling, whether it be compacted soils or vegetation displacement resulting in increased soil erosion and dust formation, we believe that livestock grazing and trampling has become a moderate threat to this species for the foreseeable future. (USFWS, 2010)

**Stressor:** Collectors (USFWS, 2010)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Cacti are desirable plants whose wild populations in the U.S. and Mexico have been subject to illegal collection and trade (Robbins 2003). Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare cacti. Many of these collectors have illegally obtained certain species for their private collections (Robbins 2003). In summary, illegal collection leads to the direct loss of plants and has threatened some S. mesae-verdae populations. Cactus collecting will probably continue at some level into the foreseeable future, but such activities are difficult to document and we have not discovered any new information to suggest that cactus theft is increasing (CITES 2000; Robbins 2003; Martin 2009). Although illegal collection of S. mesae-verdae was considered a significant threat at the time of listing and during the development of the Recovery Plan, as evidenced by the second recovery criterion which directly addresses this threat, collecting appears to have decreased since the publishing of the Recovery Plan and is now considered a minor threat to the species for the foreseeable future. (USFWS, 2010)

**Stressor:** Predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** All Sclerocactus are susceptible to disease and predation, but only predation has been observed in this species. The longhorn cactus beetle (Moneilema semipunctatum) normally feeds upon Opuntia spp. However, during the 20022003 period of severe drought, the longhorn cactus beetle fed upon S. mesaeverdae and substantially reduced all of the monitored populations. Although the longhorn cactus beetle is a native species and S. mesae-verdae has likely evolved with it, this beetle has the potential to cause serious mortality in the foreseeable future with periodic atypical population eruptions. Native to the Great Plains and Intermountain West, a migratory, noctuid moth, the army cutworm (Euxoa spp), destroyed many S. mesae-verdae in the BLM Hogback ACEC study area during the drought of 2002-2003 (Bureau of Land Management 2003b). Numerous cacti also were reported killed by the army cutworm on Navajo Nation land (Roth 2008, pers. comm.). Since this insect is generally associated with agricultural crops which are found nearby BLM and Navajo Nation lands, but will also consume native plants, particularly grasses, the threat is still substantial. In 2003, a third type of cactus predator was observed in the Colorado (Navajo Natural Heritage Program 2004). Unfortunately, the identity of the predator was not determined, but the effects to the plant appear to be similar to those from the longhorn cactus beetle (Navajo Natural Heritage Program 2004). The Service believes that insect predators can be an ongoing, yet minor threat to S. mesae-verdae. However, during atypical drought episodes, the threat from these predators can be severe into the foreseeable future. (USFWS, 2010)

**Stressor:** Pesticide use (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of S. mesae-verdae or their host plants (Service 1984). Herbicides are commonly used for noxious weed control, but no documentation has been provided on herbicide application occurring, and whether any S. mesae-verdae populations have

been directly or indirectly affected. On the other hand, agricultural use of pesticides has been reported on nearby BLM lands. Pesticides, particularly insecticides, are linked to bee declines (Kearns et al 1998; Kremen et al. 2002; National Academy of Sciences 2007), with the abundance and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008; Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (Apis mellifera) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the pollinator community than just a targeted area (Kevan 1975; Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007; Tuell and Isaacs 2010). Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests, including army cutworms (Euxoa spp). Most of the S. mesae-verdae populations are miles away and would not be impacted by drift (Sivinski 2000). However, a few cactus populations are situated near agricultural areas, such as the Waterflow population, which is close to an apple orchard and alfalfa field, yet it has been successfully setting fruit until the severe drought of 2002-2003. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of S. mesae-verdae. Thus, we do not consider pesticides to be a threat to this species in the foreseeable future. (USFWS, 2010)

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 º C (1.3 º F) during the 20th century (IPCC 2007). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. Increases in predatory insects are also predicted with climate change (Enquist and Gori 2008). This was documented for S. mesae-verdae during the drought of 2002-2003 with the unusual and extensive invasion of the longhorn cactus beetle and the army cutworm. The drought combined with concurrent insect infestations significantly reduced S. mesae-verdae populations and recovery has been extremely slow. Sclerocactus mesae-verdae is likely to have experienced and rebounded from periods of drought and cycles of insect predation in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Since the documented decline of S. mesae-verdae was concurrent with the drought of the early 2000s, the Service believes that climate change is a severe threat to this species in the foreseeable future. (USFWS, 2010)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 11C

**Delisting Criteria:**
1. Establish at least two restricted use areas for selected portions of S. mesaeverdae habitat on the Navajo Indian Reservation and on Bureau of Land Management (BLM) administered lands. (USFWS, 2010)

2. Provide S. mesae-verdae stock to trade outlets to help relieve the black market demand through the addition of 10,000 plants per year to commercial nurseries for 5 years. (USFWS, 2010)

**Recovery Actions:**
- Major actions listed in the recovery plan include species monitoring, management, and protection of the five known populations; establishment of at least two (additional) areas of restricted use; surveys of all potential species' habitat; development of a commercial artificial propagation program; and research into the distribution, population biology, and ecology of this species. (USFWS, 2010)
- Revise the recovery plan for this species to incorporate new information on biology, ecology, threats, and management recommendations. Objective and measurable recovery criteria for down and delisting of the species should be developed which addresses all listing factors relevant to this species. (USFWS, 2010)
- Recommend more stringent off-highway vehicle use restrictions and stronger enforcement of OHV laws in known and potential cacti habitat. (USFWS, 2010)
- Develop a S. mesae-verdae multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. (USFWS, 2010)
- Develop standardized survey and monitoring protocols for this species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. (USFWS, 2010)
- Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). (USFWS, 2010)
- Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. (USFWS, 2010)
- Provide legally grown seeds and plants of S. mesae-verdae to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti throughout its range. (USFWS, 2010)
- Provide viable S. mesae-verdae seeds to a seed bank operating under the Center for Plant Conservation guidelines. (USFWS, 2010)
- Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of this species. (USFWS, 2010)

- Determine microhabitat needs of this species ("nurse" plants, pollinators, precipitation needs - amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2010)
- Collect data on the biology, demographics, ecology, and movements of the longhorn cactus beetle and the army cutworm to determine their long-term significance as predators of this species. (USFWS, 2010)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • If possible given workloads, conduct a Species Status Assessment to inform the next fiveyear review and to guide the development of a revised recovery plan to reflect current number of populations, population status and demographics, and status of threats. • We recommend stronger enforcement of off-highway vehicle laws in known and potential cacti habitat. • Conduct additional research on taxonomy and genetics of the Mesa Verde cactus across the range of the species. • Finalize species range map and continue to survey areas within the species' revised range to verify the presence or absence of individuals and suitable habitat. • Develop a Mesa Verde cactus multi-agency working group to improve collaboration, discuss annual monitoring results, and to promote protection and recovery. • Develop or adopt standardized survey and monitoring protocols range-wide for this species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. • Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. • Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to clearly define the vulnerable life history stages of this species. • Determine microhabitat needs of this species ("nurse" plants, pollinators, precipitation needs - amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. • Collect data on the biology, demographics, ecology, and movements of the longhorn cactus beetle and the army cutworm to determine their long-term significance as predators of this species. • Establish additional conservation areas for the Mesa Verde cactus. • Establish an off-site conservation program to develop captive propagation techniques that follow the Center for Plant Conservation best management practices. Conduct studies to evaluate the effectiveness of seed germination and seedling establishment. • Conduct studies on the reproductive biology of Mesa Verde cactus, including pollination, seed development, seed dispersal, and inbreeding depression. • Conduct additional studies on predation, impacts of invasive species to different life stages, and other emerging threats (USFWS, 2023).

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# SPECIES ACCOUNT: *Sclerocactus wetlandicus* (Uinta Basin hookless cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 09/15/2009; Mountain-Prairie Region (R6) (USFWS, 2016)

**Physical Description**

S. wetlandicus is a barrel-shaped cactus that ranges from 4 to 18 centimeters (cm) (1.5 to 7 inches (in.)) tall, with exceptional plants up to 30 cm (12 in.) tall. The stems have typically 12 to 15 ribs that extend from the ground to the tip of the plant. Along the ribs are areoles (small, cushion-like areas) with hooked spines radiating out (Heil and Porter 2004). There are two types of spines, radial and central, defined by the size and position on the plant (see Figure 1) (74 FR 47112, September 15, 2009). The 6 to 14 radial spines are located around the margin of the areole, extending in a plane parallel to the body of the plant. The radial spines are white or gray to light brown, and are 6 to 20 mm (0.24 to 0.8 in.) long. The one to five central spines (usually three) are 15 to 30 mm (0.5 to 2.0 in.) long, are generally longer than radial spines, and extend from the center of the areole. The central spines include abaxial and lateral forms. Abaxial spines are typically single and are noticeably bent at an angle usually less than 90 degrees. Lateral spines are usually present in pairs on either side of the abaxial spine, but are more or less straight and diverge from the abaxial spine at an acute angle (usually 20 to 50 degrees). The funnel-shaped flowers usually have pink to violet tepals (petal-like flower parts not differentiated into petals and sepals) with yellow stamens (the male reproductive organ of the flower), and are 2 to 5 cm (0.8 to 2 in.) long and 2 to 5 cm (0.8 to 2 in.) in diameter (74 FR 47112, September 15, 2009). The fruit is short, barrel-shaped, reddish or reddish grey when ripe, 7 to 12 mm (0.3 to 0.5 in.) wide, and 9 to 25 mm (0.35 to 1.0 in.) long (USFWS, 2010).

**Taxonomy**

The original listing rule for S. glaucus (44 FR 58868, October 11, 1979) included all hookless (straight central spines) Sclerocactus populations in western Colorado and northeastern Utah, and referred to them as S. glaucus per Benson (1966, pp. 50-57; 1982, pp. 728-729). This taxonomic classification is not supported by the results of more recent genetic and morphological research. Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993b; Welsh et al. 2003), and a reevaluation of the morphological characteristics of S. glaucus have led to separating this species into three distinct species: S. brevispinus, S. glaucus, and S. wetlandicus (Hochstätter 1993b; Heil and Porter 2004). The Flora of North America recognizes 15 species in the genus Sclerocactus, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between S. brevispinus and S. wetlandicus, but infer S. glaucus is more closely related to S. parviflorus (Devil's claw cactus) and S. whipplei (Whipple's fishhook cactus). The common name for S. glaucus was changed to Colorado hookless cactus as the species is endemic to western Colorado. S. wetlandicus is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. S. brevispinus is now known as the Pariette cactus as it is limited to the Pariette Draw of the central Uinta Basin. The Uinta Basin hookless cactus complex will be used to refer to the combination of all three species previously listed as a single entity (USFWS, 2010).

**Current Range**

Known only from Duchesne and Uintah counties, Utah (Flora of North America Editorial Committee (2003).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Predominately insect pollinated (surrogate S. glaucus information) (USFWS, 2007)

**Breeding Season**

Adult: Flowering occurs in April-May, and fruits mature in May-June (surrogate S. glaucus information) (NatureServe, 2015).

**Reproduction Narrative**

Adult: Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantely outcrossing but is marginally self-compatible. Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of Sclerocactus glaucus (NatureServe, 2015). Information from S. glaucus is being used a surrogate information for S. wetlandicus due to the species similiarities and based on the following quote 'Because we lack life history data specific to S. wetlandicus, we have included life history data for S. glaucus, which should correlate to characteristics for S. wetlandicus' USFWS, 2010. Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015). The species’ life history is poorly known, but it is thought to be a longlived perennial usually flowering after 3 or 4 years. A broad assemblage of native bees, and possibly other insects including ants and beetles, pollinates S. brevispinus (USFWS 1990, p. 7) (USFWS, 2007).

**Habitat Type**

Adult: Salt desert shrub (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred form NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred form NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits salt desert shrub communities and pinon-juniper woodlands on river benches, valley slopes, and rolling hills (Franklin 2005). Gravel-covered clay hills, desert grasslands, saltbush, and rabbitbrush flats (Flora of North America Editorial Committee 2003). (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species habitat requirements of the species and the relatively small geographic area this species inhabits.

***Dispersal/Migration***

**Dispersal**

Adult: Believed to be dispersed by heavy down-pours (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015)

***Population Information and Trends***

**Population Trends:**

Unknown

**Number of Populations:**

6 - 80 (NatureServe, 2015)

**Population Narrative:**

Approximately 8 occurrences observed since 1989 and 17 others last observed earlier (UTNHP 2009). (NatureServe, 2015). We do not have long-term status or trend population (USFWS, 2010). Low resiliency, redundancy and representation are inferred based on the relatively low number of known populations and the small geographic area this species is known to inhabit. data for S. wetlandicus (USFWS, 2010).

***Threats and Stressors***

**Stressor:** Oil and Gas Development and Associated Impacts (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The BLM is monitoring S. wetlandicus and neighboring Sclerocactus species, including impacts associated with oil and gas development. Initial results show that there may be impacts from oil and gas development (i.e., roads and well pads) on the survival and reproductive success of S. brevispinus (72 FR 53215, September 18, 2007), and similar effects could be expected for S. wetlandicus (USFWS, 2010).

**Stressor:** Collection (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Illegal collection is a significant threat to S. wetlandicus. The original listing of S. glaucus concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age

individuals, leaving behind a younger, less reproductive population. Approximately 40 percent of the potential habitat of S. wetlandicus is within 400 meters (1,312 feet) of a well (Service 2009). Such development facilitates human access and discovery by illegal collectors (72 FR 53216, September 18, 2007) (USFWS, 2010).

**Stressor:** Livestock Grazing and Trampling (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** A majority of S. wetlandicus potential habitat on BLM land is leased for grazing. At least 28 grazing allotments overlap with S. wetlandicus potential habitat, with both cattle and sheep grazing continuously and on deferred rotation. Livestock grazing results in S. wetlandicus mortality when livestock trample individual cacti (Service 1990; Utah Natural Heritage Program 2006; BLM 2008; 72 FR 53215, September 18, 2007). Overgrazing—the continued heavy grazing beyond the recovery capacity of forage plants (Vallentine 1990) - by domestic livestock degrades western ecosystem functions and structures (Fleischner 1994). Overgrazing can facilitate the establishment of invasive species like cheatgrass (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. Invasive weeds (including Bromus tectorum and Halogeton glomeratus) are prevalent on BLM lands in the range of S. wetlandicus cactus and less so on tribal lands where grazing has been concentrated in areas outside of suitable cactus habitat (72 FR 53214, September 18, 2007) (USFWS, 2010).

**Stressor:** Predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Parasitism by the cactus-borer beetle (Moneilema semipunctatum) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 72 FR 53216, September 18, 2007). Parasitism is identified as a threat to Sclerocactus plants; however, additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to S. wetlandicus. Another source of mortality is lagomorph and rodent browsing. While there have been numerous observations Sclerocactus being removed by desert cottontail rabbits (Sylvilagus audubonii) and unknown rodents (Colorado Natural Heritage Program 2010b; BioLogic 2008; Clayton 2006), in subsequent years some of these plants have re-sprouted (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat (USFWS, 2010).

**Stressor:** Climate Change, Drought, and Impacts to the Vegetative Community (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Climate change is likely to affect long-term survival of native species, including S. wetlandicus, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979

baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of S. wetlandicus. While the potential impacts of climate change could be serious, improved projections are needed to better understand this potential threat. S. wetlandicus mortality due to drought is well documented (Service 1990; 72 FR 53217, September 18, 2007). Many dead S. wetlandicus individuals were observed in the Uinta Basin after the severe drought of 1976 to 1977 (Service 1990). In addition, noxious weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM’s efforts to control noxious weeds and restore native vegetation, which is already difficult due to the extreme environment of the Uinta Basin (Service 1990; BLM 2005, 2008) (USFWS, 2010).

**Stressor:** Herbicides and Pesticides (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of indivduals
**Narrative:** S. wetlandicus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as noxious weeds and insect pests (Service 1990). Individual cacti are likely to be directly affected by these chemicals, and indirectly by effects on pollinators or by movement of contaminated soils (Service 1990). However, specifics of the species' pollination biology are currently unquantified (USFWS, 2010).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** We are not aware of any city, county, or State laws, ordinances, or zone that provide for protection or conservation of the S. wetlandicus or its habitat. Removal, damage, or destruction of plants on private lands is not prohibited under the Act. Removal from Federal lands is prohibited without a permit, but can be allowed through consultation with the Service. The BLM sometimes authorizes adverse effects to the S. wetlandicus if it will not jeopardize the continued existence of the species. Conservation needs of S. wetlandicus are addressed through interagency consultation (section 7 requirements) typically between the Service, BLM, and Bureau of Indian Affairs. Through this process, conservation measures are implemented on a project-by-project basis to minimize the loss of individual cacti from oil and gas activities. These measures include preconstruction cactus surveys and a required buffer around individual cacti. For example, the Castle Peak/Eightmile Flat Oil and Gas Expansion Project Final Environmental Impact Statement included conservation measures to specifically protect S. wetlandicus and its habitat (BLM 2005). In addition to these project-specific protections, we need to establish consistent guidance and Resource Management Plan designations that provide adequate regulatory mechanisms over the longer term to protect large portions of the range of the S. wetlandicus (USFWS, 2010).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8C

For Uinta Basin hookless cactus – The metapopulation has a stable or increasing growth trend (average lambda (λ) ≥ 0.95) over a minimum period of 10 consecutive years and predictive modeling (using data from the same 10-year monitoring period) indicates that the likelihood for long-term survival of the metapopulation is at least 95 percent over a 100-year period. In addition: a. At least 8 of the 11 core 2 areas have a stable or increasing growth trend (average lambda (λ) ≥ 0.95) over a minimum period of 10 years to demonstrate metapopulation stability. b. The eight core 2 areas evaluated should incorporate the principles of redundancy and representation by including core areas that represent the full distribution of the species (i.e., core areas from the furthest north, south, east, and west boundaries, representation from all habitat types, and range of elevation) (USFWS, 2023).

For Uinta Basin hookless cactus – The metapopulation maintains a size distribution that contains individuals in all size classes over a 5-year minimum period and where the largest size class maintains a stasis rate no less than 0.90. Size classes for Uinta Basin hookless cactus are defined as: class 1:< 21.2 mm; class 2: 21.2–51 mm; class 3: 51.1–80 mm; and class 4: >80 mm (Hornbeck 2020) (USFWS, 2023).

For Uinta Basin hookless cactus – Genetic diversity across the metapopulation is maintained at levels such that there is a high probability (95 percent) of two core 1 populations persisting over the long term (100 years) within each core 2 area (USFWS, 2023).

For Uinta Basin hookless cactus – Disturbance that contributes to the degradation and loss of habitat (e.g., roads, recreation, livestock) does not exceed established tolerance thresholds for each core 2 area (percent of habitat) (USFWS, 2023).

For Uinta Basin hookless cactus – Protected areas will be formally established by land managers for at least one genetically important population and at least one connectivity corridor (as identified using connectivity analysis) to provide long-term protection from anthropogenic threats. Methods may include but are not limited to Areas of Critical Environmental Concern (ACECs), Resource Management Plan special designations, Tribal resolutions, conservation agreements, and conservation easements (USFWS, 2023).

**Recovery Actions:**

- Priority 1 Actions 1. Monitor two core 1 areas within each core 2 area for Pariette cactus and eight core 2 areas for Uinta Basin hookless cactus to evaluate short- and long-term population trends across the metapopulation and support predictive modeling. Monitoring should be conducted for a minimum of 10 years (Recovery Criteria 1 and 2). 2. Reduce impacts from livestock, feral horses, and herbivores on a landscape scale (in all subpopulations) through herd management, grazing rotations and rest, and habitat improvements (Recovery Criterion 1). 3. Develop disturbance tolerance thresholds for each core 2 area (Recovery Criterion 4). 4. Formalize conservation measures with partners to be implemented with, and prior to, all surface disturbing projects. Conservation measures may be documented in a memorandum of understanding, resource management plan, conservation agreement, recreation management plan, travel management plan, or similar document (Recovery Criteria 1, 2, 3, 4, and 5). 5. Restore disturbed areas within core habitat so that new surface disturbance is less than the tolerated threshold identified in Recovery Action 3 (Recovery Criteria 1, 2, and 3). 6. Resurvey subsampled areas (targeted and repeat) to update abundance and population estimates (Recovery Criteria 1, 2, 3, 4, and 5) (USFWS, 2023).

- A Recovery Plan has not been published for this species.
- Priority 2 Actions 7. Evaluate current genetic diversity across the species range to identify subpopulations at risk, those needing protections, and those of high importance (Recovery Criterion 2). 8. Conduct a connectivity analysis to identify important gene flow corridors (Recovery Criterion 2). 9. Restore or improve connectivity corridors between core 1 and core 2 areas that are important for maintaining gene flow across the species range and limit new surface disturbance in important existing connectivity corridors (Recovery Criteria 2 and 3) (USFWS, 2023).
- Priority 3 Actions 10. Update disturbance calculations on an annual basis for each core area (Recovery Criterion 3). 11. Develop a predictive model to evaluate the long-term trend and projected survival probability of each species under likely future scenarios, including climate change (Recovery Criteria 1, 2, 3, 4, and 5). 12. Reestablish Sclerocactus individuals on restored sites and monitor effectiveness (Recovery Criteria 1, 2, and 4). 13. Establish areas for permanent protections that provide the greatest benefit towards maintaining the redundancy, representation, and resiliency of the species (Recovery Criteria 1, 2, 3, and 5). 14. Develop and implement management plans for each protected area (Criterion 5) (USFWS, 2023).

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# SPECIES ACCOUNT: *Sclerocactus wrightiae* (Wright fishhook cactus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/11/1979; Mountain-Prairie Region (R6) (USFWS, 2016)

**Physical Description**

Wright fishhook cactus (Sclerocactus wrightiae) is named for Dorde Wright Woodruff who discovered Wright fishhook cactus (L. Benson) in Emery County in 1961 (Benson 1982). The species is endemic to south-central Utah occurring in scattered clusters in Wayne, Emery, and Sevier counties. Wright fishhook cactus is a small, perennial globose shaped cactus mainly 6 – 12 cm long and 4 - 8 cm in diameter growing as a single plant with a branched taproot (Welsh et al. 2008). If damaged, the cactus may form multiple stems. Spines, both lateral and central, emerge from warty protuberances called tubercles. The large, lower central spine is hooked, a noticeable character that gives the cactus its common name of "fishhook." The flower is 3 to 4 cm in diameter, 3 to 4 cm long, white to cream or pink and fragrant. Sepaloids are green or green tinged with red or brown. Flowering occurs from late April through May and fruits are set in June. Fruits are barrel shaped and borne on the top of the cactus. Seeds are black, 2 mm long and 3.5 mm broad (Heil and Porter 1994). A distinguishing characteristic of the Wright fishhook cactus is the presence of magenta filaments with yellow anthers. Short spine length, round spines, early flowering time, small flower size, and magenta filaments help distinguish this species from other similar cacti (Heil and Porter 1994, Benson 1982).

**Current Range**

The overall range of the species has not changed significantly since the publication of the 1985 Recovery Plan (USFWS 1985). However, survey and inventory efforts have greatly expanded our knowledge of the distribution of the species within its range. We now know of more occupied sites that form a more continuous metapopulation than previously known. The known range of Wright fishhook cactus extends across approximately 993,705 acres (ac) (402,138 hectares (ha)) of Utah's western Emery County, southeastern Sevier County, and central Wayne County (USFWS, 2022)

**Critical Habitat Designated**

Yes;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Almost completely self-incompatible and pollination is accomplished mostly by native sweat bees

**Reproduction Narrative**

Adult: Wright fishhook cactus is almost completely self-incompatible and pollination is accomplished mostly by native sweat bees (Halictidae) (Tepedino 2000). Eight species of bees from one family (halictid bees) and two genera (Dialictus and Agapostemon) are known to visit Wright fishhook cactus (Tepedino 2000). Pollination is limited by the foraging distance of the ground nesting bees, which is strongly correlated to body size (Greenleaf 2005). The distance that ground nesting bees travel from their nests is difficult to determine but it is believed that they do not travel far; the maximum travel distance reported for the two genera that pollinate Wright fishhook cactus is approximately a quarter mile (400 m) (Tepedino 2000). Cross pollination is essential for Wright fishhook cactus to produce viable seeds; self-pollination would result in production of non-viable seeds. Little is known about the species' seed banks, seed viability, germination, dispersal, dormancy and establishment in the wild. Seeds fall directly from the base of the dry fruit onto the ground and most are believed to remain near the parent plant (USFWS 1985). Possible dispersal vectors include gravity, wind and water erosion, as well as insects and rodents (USFWS 1985, Kass 1990).

**Habitat Type**

Adult: Flat areas, low ridges and slopes

**Environmental Specificity**

Adult: Moderate (NatureServe, 2015)

**Habitat Narrative**

Adult: Wright fishhook cactus occurs on semi-barren sites on flat areas, low ridges and slopes in sparsely vegetated arid desert environments. They occur in a variety of vegetation types including desert scrub, desert grasslands, and open pinyon-juniper woodland communities. Wright fishhook cacti are generally found between 1,290 and 2,300 m (4,230 and 7,545 ft) and occur on a variety of geologic formations including Curtis, Mancos Shale, Morrison, Summerville, Dakota, Carmel, Entrada, and Moenkopi. Soils where the species is found include a broad range of textures, including clays, sandy silts, fine sands, loam and loamy sand. Soils generally have an overlying layer of fine and medium sized gravels or a cryptobiotic soil surface crust (USFWS 1985, Kass 1990). The overall range of the species has not changed significantly since the publication of the 1985 Recovery Plan. However, survey and inventory efforts have greatly expanded our knowledge of the distribution of the species across its range. We now know of more occupied sites and in some cases, more continuous populations than at the time of listing. The known range of Wright fishhook cactus extends across approximately 696,099 acres (ac) (281,701 hectares (ha)) of Utah's western Emery County, southeastern Sevier County, and central Wayne County. Wright fishhook cactus occurs primarily on lands managed by the BLM's Price and Richfield Field Offices and by the NPS at CRNP. More than 300 localities of Wright fishhook cactus have been documented from BLM and CRNP lands. A cactus locality consists of one or more individual cacti. There are 22 localities on lands managed by the BLM's Price Field Office, 256 localities on lands managed by the Richfield field office, and 55 localities on CRNP lands. Ninety-five percent of the Wright fishhook cactus range occurs within 22 active grazing allotments, including BLM, CRNP, SITLA, and private lands. Grazing is not permitted on the BLM North Caineville Mesa (2,200 ac (890 ha)) and a small section of the Factory Butte SRMA (approximately 1,300 acres (526 ha)). Although grazing is not permitted at Goblin Valley State Park, portions of the park are not fenced and are therefore accessible to livestock from adjacent lands. The CRNP section of the Cathedral grazing allotment was retired in 1999; however, livestock trail through the area each fall when moving between their summer and winter ranges. Our most recent range-wide population estimate is 4,500 - 21,000 individuals (USFWS 2008). Inventory efforts within CRNP during 2011 – 2013 documented 2,551 live individuals in 55 localities (CRNP 2014b). This should be considered a conservative number as counting and mapping efforts at each locality were limited to four person-hours, and therefore not all cacti at a locality were counted. Potential habitat is widely available in the vicinity of known localities of the species throughout its range, and because the species is a relative generalist, abundance of habitat is not considered a limiting factor in the conservation or survival of the species. Much of this additional potential habitat has yet to be surveyed. During the 2014 field season CRNP staff conducted 106 belt transects to gather presence/absence data on Wright fishhook cacti and Winkler cacti within suitable habitat that has not been previously inventoried (Clark 2014). These efforts located 546 previously unmapped Wright fishhook cacti. Although additional Wright fishhook cactus localities have been found since the species was listed, we cannot determine a trend. Previous surveys are not comparable because we do not have a measure of acreage surveyed or effort spent searching. The earliest estimates of 50,000 to 100,000 (Neese 1987, Kass 1990, Kass 2001a) are most likely not accurate because subsequent surveys do not support this estimate. In recent inventories conducted from 2011 and 2012, BLM and CRNP (BLM 2012a, CRNP 2012, CRNP 2013) found 10,724 individual cacti in 157 localities with the majority on BLM land. This number is likely to increase as inventories of the remaining known localities are made.

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

130

**Population Size:**

2,348

**Population Narrative:**

Wright fishhook cactus is a long-lived species that is slow to reach reproductive maturity. Individual cacti begin flowering when around 4 to 5 years old, producing flowers generally less than 50 percent of the time (Kass 2001a, Clark and Clark 2007). The highest reproductive rates are associated with large adult plants (>3.5 in [9.0 cm] in diameter), which flower between 75 and 100 percent of the time producing a disproportionately large amount of seeds (Kass 2001a, Clark and Clark 2007). Depending on environmental conditions, Wright fishhook cactus is estimated to grow an average of 0.2 ± 0.1 in (0.5 ±0.25 cm) in diameter within one year (Clark and Clark 2007) with seedlings growing at a faster rate than adults (Kass 2001a). Because of slow growth rates, the highest reproductive individuals may be at least 18 years old. Size class distribution of a population indicates its structure and stability, and can help to show vulnerabilities in each life stage. Between 1999 and 2008, Clark (2008a) collected size class data on Wright fishhook cactus collected at 130 of 151 sites surveyed. During these surveys, 2,348 cacti in the four size classes (excluding multiple stemmed plants) were recorded as follows: 10 percent seedlings, 37 percent juveniles, 52 percent young adults, and 2 percent old adults. Although it is likely that some seedlings were missed during this inventory effort, the percentage of old adults is likely accurate (Clark 2008a). Similar population structure results were reported from three demographic monitoring sites on BLM lands over a seven year period with most of the population in the young adult size class (Kass 2001a). Monitoring initiated at Factory Butte in 2009 also showed low numbers of seedlings (5 percent), higher numbers of juveniles (21 percent) and young adults (68 percent), and low numbers of older adults >8 cm in diameter (6 percent) (Clark 2009a). Overall, the majority of Wright fishhook cactus plants occur in the juvenile to young adult size classes throughout the range of the species (Kass 2001a, Clark and Clark 2007, Clark 2008a, Clark 2009a) with the largest and smallest size classes poorly represented. Low frequency in the occurrence in the smallest size classes indicates low levels of recruitment into the population. Demographic monitoring over a seven year period at three BLM Wright fishhook cactus monitoring plots reported a mortality to recruitment ratio of 2.5:1 in all plots (Kass 2001a). Low levels of recruitment are also reported in the Factory Butte area, where overall mortality was 8.9 percent between 2009 and 2010, and 6 percent between 2010 and 2011 (BLM 2012a). The mortality to recruitment ratio for both years was reported at 6:1 and 5:1, respectively (BLM 2012a). Low recruitment patterns and the small number of large older reproductive individuals may constitute a species wide pattern (Kass 2001a). For populations to persist in their environment, recruitment into the population must exceed mortality. Populations with a low percentage of seedlings or a low percentage of the highly reproductive individuals are potentially declining populations (Elzinga et al. 1998).

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats to the species include damage to the habitat during mineral and gas exploration and the mining of coal, gypsum, bentonite and bentonite clay, uranium, vanadium, building stone and gravel. Livestock activity, such as trampling and uprooting of plants, is a threat. Off-road vehicle use causes damage. Illegal collecting is still a problem. The cactus apparently suffers from predation by the beetle Moneilema semipunctatum and perhaps other beetles. Small mammals such as Ord's kangaroo rat (Dipodomys ordii) and white-tailed antelope squirrel (Ammospermophilus leucurus) may eat the cactus. (NatureServe, 2015)

**Stressor:** Poaching (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Illegal collection of Wright fishhook cactus is a range-wide stressor that likely continues although the current scale of this effect is unknown. Wright fishhook cactus is desired in cactus collections and the Park has documented signs of scouting and poaching for the species, and illegal advertisements online. (USFWS, 2022)

**Stressor:** Drought (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Future climate projections for the southwest include more intense and longer-lasting heat waves, fewer cold periods, an increased probability of droughts that are worsened by higher temperatures, reduced snowpack, earlier snow melt and more frost-free days (Garfin et al. 2014, Melillo et al. 2014). Projections for precipitation changes are less certain than predictions for temperature and may increase in some areas and decrease in others (Garfin et al. 2014). However, it is expected that more precipitation will be in the form of rain versus snow, which can increase flooding of dry washes, and will occur as extreme precipitation events (Frankenson et al.

2018). As a desert species, Wright fishhook cactus has adapted to tolerate periodic drought conditions; therefore historic droughts patterns alone are not expected to cause a decline in species stability or trend. The ability to go dormant during drought periods and possessing contractile roots to retract low to the ground to reduce water loss and sun scald are two adaptive strategies that Wright fishhook uses during seasonal droughts. An analysis was attempted to distinguish between livestock effects and drought effects under current and future scenarios. However, due to the synergism between drought stress, livestock trampling, and herbivory, the degree to which drought plays a role in the population trend remains unclear (Hornbeck 2020b). (USFWS, 2022)

**Stressor:** Climate Change (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change was not identified as a threat at the time of listing or in the recovery plan. Wright fishhook cactus appears to be highly vulnerable to future climate conditions based on one evaluation that predicted considerable range loss for the species after 2040 (Krause 2010). Wright fishhook cactus was also ranked as “extremely vulnerable” to climate change using a climate vulnerability index and an evaluation of current verses future suitable habitat locations (Still et al. 2015). The species predicted vulnerability to future climate conditions using predictive models and the index were based on factors that include the species’ small current range, limited dispersal ability, and lack of overlap between current and future areas of suitable habitat (Krause 2010; Still et al. 2015). (USFWS, 2022)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5C

***Conservation Measures and Best Management Practices:***

- Recommended future actions: Based on recent discussions with conservation partners, we recommend the following future actions: 1. Work with partners to protect as much occupied and potential habitat as possible and improve habitat conditions for plants and pollinators by providing intact or restored habitat conditions; 2. Work with partners to restrict recreational use and restore degraded habitat areas to support the species and its pollinators; 3. Work with partners to collectseeds periodically from all populations to provide a genetically representative, off-site seed collection; 4. Establish a range-wide population trend monitoring program that is consistent and comparable on CRNP and BLM lands; 5. Continue existing livestock disturbance monitoring throughout the species range; 6. Continue existing OHV recreation disturbance monitoring and enforcement at FactoryButte SRMA; 7. Work with partners to improve species census data, especially within CRNP, and utilizing novel survey techniques such as drone surveys; 8. Work with researchers to develop a fine-scale species distribution model using censusimagery to identify favorable seedling microsites for seed additions and support future population augmentation efforts on BLM; 9. Work with partners and researchersto conduct a germination study on BLM and CRNP to inform population models and understanding of recruitment and population dynamics; 10.Continue to investigate propagation methods for the species to reduce plant and population losses and preserve genetic diversity; and 11.Work with researchers to develop an annual detectability estimate for the species based on population monitoring data to calculate the percentage of the population above ground and detectible for section 7 consultation effects analyses and population estimates.

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# SPECIES ACCOUNT: *Scutellaria floridana* (Florida skullcap)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Southeast Region (R4) (USFWS, 2015) 5/8/1992

**Physical Description**

A perennial herb, up to 4 dm tall. Stems are solitary or few, mostly erect or ascending. Leaves are opposite, narrowly linear, 2-4 mm long, the margins strongly rolled. Flowers are solitary in the axils of leaves and are bright lavender-blue with a whitish throat. (Based on Kral 1983.) (NatureServe, 2015)

**Taxonomy**

The rarest of several southeastern species in this genus. (NatureServe, 2015)

**Historical Range**

See current range/distribution.

**Current Range**

Known from the Apalachicola region of the Florida panhandle from Liberty, Franklin and Gulf counties. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: Perrenial (USFWS, 2009)

**Breeding Season**

Adult: Flowering is in May and June (Kral 1983) (USFWS, 2009).

**Reproduction Narrative**

Adult: The Florida skullcap is a perennial herb with quadrangular stems and opposite leaves. The flowers are solitary, with a bell shaped calyx and bright lavender-blue corolla. The corolla has two lips, the lower one being white in the middle. The stigma sticks out from under the flower hood with the anthers residing inside. Bumblebees, megachilids and halictids are probably important pollinators. Plants flower from mid-April through early July and are most prolific after a fire UUSFWS, 2009).

**Habitat Type**

Adult: Pine-palmetto flatwoods, wet prairies (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (Inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (Inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits dark, humus rich sands of pine-palmetto flatwoods, wet prairies, and savannahs. (Based on Kral 1983) Seepage slopes. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (inferred from NatureServe, 2015)

**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

19 protected populations (USFWS, 2024)

**Population Size:**

>100,000 total (USFWS, 2024)

**Population Narrative:**

Reported to respond positively to fire by sprouting and blooming. They stop flowering if not burned at least once every three years. Pollinator visits were infrequent in one study that examined who and when pollinators visited Scutellaria floridana. In addition, native bees were the primary pollinator, and factors that effect bee density could affect S. floridana density. Based on recent surveys within range and habitat of the species (NatureServe, 2015). Moderate resiliency, representation and redundancy are inferred based on number of populations and individuals as well as relatively large area in which this species is known to occur. Florida Natural Areas Inventory had estimated hundreds of thousands of flowering stems for multiple occurrences (Florida Natural Areas Inventory 2017-2023, A. Johnson, 2023, pers. comm). However, because of the clonal system for this species, stem counts alone are an imperfect proxy for abundance in S. floridana populations as one individual can be composed of dozens of stems with no clearly delineated shape or arrangement across the landscape (Hanko et al. 2023); clonal diversity in 12 studied populations showed that one to 16 clones were present in a single population. Scutellaria floridana is a perennial mint endemic to four counties in the Florida panhandle (Figure 1). It grows in fire-dependent habitats such as longleaf pine wet forests and wet meadows and has a strong response to fire (Negron-Ortiz 2023). It can also occur in appropriate habitats within road/transportation and/or transmission rights-of-ways that are maintained. There were originally 40 historically documented occurrences throughout this species range (Service 2009, 2019). Since points within 1 km are all considered part of one occurrence (NatureServe 2020), the 40 historical occurrences represent 29 Element Occurrences (hereafter EOs or occurrences; Service 2009, 2019). ⍰ Currently, there are 19 extant, protected EOs. These EOs continue to be threatened by urban development, timber farming, and fire suppression (USFWS, 2024)

***Threats and Stressors***

**Stressor:** Logging (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Pulpwood production in the outer Coastal Plain in the Apalachicola Basin The timber industry in North Florida became well established in the 1850s (FNAI 2005). It started in Franklin County in the 1870s and continued to be a prominent industry until the mid-1990s (Howell and Hartsell 1995). The St. Joe Timberland Company had close to a million acres in timber in the eastern region of the panhandle and they plan to continue to harvest and replant indefinitely. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. According to J. Huffman (2009, pers. comm. to Negron-Ortiz) tree farming, i.e., privately owned forest managed (clearcutting, mechanical site preparation, and pine plantations) for timber production, is a primary threat since there still is a mill in Panama City (Bay County) and there are many thousands of acres of tree farms that are smothering out S. floridana (as in around the SJBSBP). Therefore, tree farming is a threat to this species (USFWS, 2009).

**Stressor:** Real estate development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Urban development continues to threaten Florida skullcap. The St. Joe Timberland Company still owns the former extensive timber land in Northwest Florida, and now focuses on commercial and residential development along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (http://www.1000friendsofflorida.org/PUBS/2060/01-Northwest-Florida). Several S. floridana's locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed roadside; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, development, road widening and new roads continue to pose a threat to the species from direct habitat loss to severe habitat modification. As explained under C.1.e, this plant has unique habitat characteristics. Working together with partners on road maintenance activities, we can find possible alternatives that will support or maintain S. floridana (USFWS, 2009).

**Stressor:** Fire suppression (USFWS, 2009)
**Exposure:**
**Response:**

**Consequence:** Loss of habitat
**Narrative:** Suppression of fire continues to threaten the pineland and savanna's flora since fire is essential for the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Thus, fire suppression continues to be a threat to S. floridana. Lack of fire, and subsequent growth of shrubs (particularly encroachment of Cyrilla racemiflora L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008). Declining fire frequency reduces S. floridana abundance in areas where it was previously observed in great quantities (FNAI 2008). In recently burned areas, however, plant emergence is prolific within one year of the fire event (L. Keppner, 2008, pers. comm.). Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., 1-3 yr interval, are needed to maintain optimal S. floridana populations. At present, the ANF utilizes a 3-5 yr interval burn rotation, Lathrop Bayou uses a 2-7 yr interval, and SJBSBP uses a 2-5 yr interval (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 2C

**Delisting Criteria:**
For delisting the species, the goal is to adequately protect and manage 15 populations distributed throughout the species' historical range for 10 years. The plan states that these goals are by necessity only preliminary, and they will be refined (USFWS, 2009).

**Recovery Actions:**
- Protect and manage these plants outside Apalachicola National Forest (USFWS, 1994).
- Protect populations in Apalachicola National Forest and on other public lands (USFWS, 1994).
- Perform systematic and other studies (USFWS, 1994).
- Garden propagation and reintroduction (USFWS, 1994).
- Manage rights-of-way (USFWS, 1994).
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range (USFWS, 2009).
- Determine the levels and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices. For example, the identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations (USFWS, 2009).

- Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants (USFWS, 2009).
- Conduct population studies. a. Studies on the viability of dry-stored seeds, the timing of germination, and whether a persistent seed bank is present should be addressed. b. Establish and implement monitoring to address demography. Plants should be monitored several times during the first 12-month period to assess the best monitoring schedule (e.g. annually, biannually). Data from monitoring should be evaluated through 5-year reviews. • Establish permanent plots on protected locations throughout the species' historical range. Priority for populations should include those sites that can be managed with fire. For each plot: o Estimate the density, and abundance of individuals. If possible, investigate basic ecological questions (e.g., pollinators; flowering period; annual variability in flowering; seed production). o Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure (USFWS, 2009).
- Manage ROWs Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and USFWS; a management plan should be developed and implemented (USFWS, 2009).
- The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Estimate the levels of clonality and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices. Sampling should involve the established monitoring plots (see page 3 Recovery action 1) • By understanding clonality, the Service will be able to determine what is an individual and evaluate abundance. Specifically, we will be able to 1) relate flowering stems (both vegetative and flowering) to number of individuals in a given area, and 2) infer the effect of fire on flowering stems/individuals. • The identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations. 2. Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range. Given the cryptic nature of this plant when it is not flowering, the density of surrounding vegetation and the number of locations, surveys are best recommended a ~5 weeks post-fire, if the fire is in the growing season; or in April or May if the fire was in Dec-Mar time period (A. Jonhnson, FNAI, 7/06/2019). A consistent and repeatable method should be employed. • Censuses are most critical for populations outside ANF. Surveys that have been accomplished following fire in the ANF (in the past 10 years by FNAI, Ann Johnson, and local botanists) have been extensive and thorough (A. Jenkins, FNAI, 6/27/2019). 3. Monitoring. It is recommended to set up more subplots and monitor both flowering and nonflowering individuals over time. • Population census data [e.g., the total number of individuals (flowering and nonflowering plants), and whether seedling recruitment is occurring] will help predict extinction risks and the smallest size at which a population can exist without facing extinction by using computer simulations known as population viability analyses. Emphasis should be given to clones and individuals with unique profiles identified by genetic study. If possible, investigate basic ecological questions [e.g., pollinators; flowering period; annual variability in flowering; seed production; and the effect of fire (if the areas are burned) on density, fecundity, and size structure]. See page 3 for details of ongoing investigations in the ANF. • A repeatable method should be employed. If the target population is small (e.g., 200 m2 ), it is recommended to walk the entire area and count each individual. If the target population covers a large area, then permanent marked transects should be established in key selected areas that reflect the larger area. 4. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. • FNAI developed occurrence-based suitable habitat model for S. floridana in 2011, and many new locations have been discovered since that time. Recommendation: Update the current model with most recent survey data (A. Jenkins, FNAI, 6/27/2019) and validate the model. 5. Manage ROWs Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and the Service; a management plan should be developed and implemented. 6. The recovery plan should be updated to define objective measurable criteria and better address the five factors. (USFWS, 2019)

- RECOMMENDED FUTURE ACTIVITIES 1. Address continued monitoring and management. a. Continue the long-term monitoring in the Apalachicola National Forest sites and set up plots in other sites such as St. Joseph Bay State Buffer Preserve, Tate’s Hell State Forest, and Lathrop Bayou. b. As sea levels rise, saltwater intrusion increases in duration, frequency, and spatial extent. To assess the effect of salinity on S. floridana, sites where intrusion of salt water occurs should be considered for long-term monitoring. c. Develop a stand-alone plan for managing listed plants at the Apalachicola National Forest and Tate’s Hell State Forest and integrate it to their Management Plans. 2. Conduct surveys/inventories on targeted sites. Based on Hanko et al. (2023), the genetic study showed that stem counts alone may not accurately reflect abundance in populations with low clonal richness; one individual can be composed of dozens of stems. It appears that on average, ten adjacent stems generally represent 1–2 unique individuals, suggesting that stem counts are usually equivalent to ten times the true population size. a. Gulf County. Thorough surveying of populations located on private lands (North Gulf Co., Fig. 1, sites with yellow and black symbols) is recommended to determine whether S. floridana and corresponding habitat are still present. This action is a priority for this species. b. In-depth investigation of clonal reproduction and management history of the four populations on public lands (Box-R Wildlife Management Area 1, Apalachicola National Forest 5, Tate’s Hell State Forest 1, and St. Joseph Bay State Buffer Preserve 1; Fig. 1) that possess very low genetic diversity and evidence of inbreeding. 3. Conduct surveys/inventories on potentially new sites (targeting recently burned sites). This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. 4. Manage Right-of-ways (ROWs) Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Florida Department of Transportation, and the Service; a management plan should be developed and implemented. 5. Establish (or continue) frequent growing-season fire regimes (i.e., 3- to 5-year interval) on selected areas such as the Apalachicola National Forest, St. Joseph Bay State Buffer Preserve, Tate’s Hell State Forest, and Lathrop Bayou to maintain optimal conditions of populations. Re-visit sites shortly after a burn event, and mark and count individual ramets. Populations tend to be more evident after a fire event (Negron-Ortiz 2023) (USFWS, 2024).

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# SPECIES ACCOUNT: *Senecio layneae* (Layne's butterweed (=Packera))

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/18/1996; Pacific Southwest (R8)

**Physical Description**

A perennial herb of the aster family (Asteraceae) that sprouts from a rootstock. Its mostly basal lance-shaped leaves are 8 to 24 centimeters (3 to 10 inches) long. The several flower heads are 4 to 6 centimeters (2 to 3 inches) wide. Each flower head has 5 to 8 orange-yellow ray flowers (the flowers usually located on the edge of the inflorescence of members of the aster family) and numerous yellow disk flowers (flowers in the center portion of an inflorescence of a member of the aster family). Senecio aronicoides (rayless groundsel), S. flaccidus var. douglasii (Douglas' groundsel), and S. vulgaris (common groundsel) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). These Senecio species can variously be differentiated from S. layneae by a combination of life form, type of flower, number of flower heads, flower color, and pubescence. (USFWS, 2002)

**Taxonomy**

Kate Layne-Curran collected the type specimen for Senecio layneae in May 1883 from El Dorado County, California, on Sweetwater Creek, not far from Folsom. Edward L. Greene first described S. layneae in 1883 (Greene 1883). Although Asa Gray (1884) reduced S. layneae to a variety of S. fastigiatus, it currently is known as S. layneae (Barkley 1993). Senecio layneae is a member of the aureoid group of Senecio that is united by most of the following characters: perennial herbs arising from creeping rootstocks or a stout caudex; well developed basal leaves with cauline (arising from the upper part of the stem) leaves progressively reduced upward; leaf margins without callose denticles (hard teeth); thin branching fibrous roots; and haploid chromosome numbers 22 or 23, or derived from these numbers (Barkley 1988). The aureoid group of Senecio is now known by some as the genus Packera. The type population of S. layneae is now thought to be extirpated due to inundation by Folsom Lake. (USFWS, 2002) In the second edition of the Jepson Manual, the genus to which Layne's butterweed belongs was changed from Senecio to Packera (Baldwin et al. 2012). (USFWS, 2019)

**Historical Range**

In western El Dorado County that includes the Pine Hill formation and adjacent serpentine; a few other colonies occur in the Eldorado National Forest in El Dorado County, California. (USFWS, 2002)

**Current Range**

On the Pine Hill formation in western El Dorado County, California; a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2002)

**Breeding Season**

Adult: Senecio layneae is a perennial herb that flowers from April to July (USFWS, 2019).

**Other Reproductive Information**

Adult: It is unclear whether the species has the ability to resprout from its caudex after disturbance (Marsh and Ayres 2002). Although the seed of this species seems to germinate in a wide range of soil conditions and adult plants grow in a wide range of slope, aspect, light and elevation levels (Williams 2014), it appears to have little or no persistent seedbank, a short seed dispersal distance (Williams 2014), and is also shade intolerant (Baad and Hanna 1987). It is likely the species functions as a fugitive species, depending on a short fire return interval to create a regeneration niche and a supply of the short-lived seed from a nearby reproducing population to colonize the patch (Marsh and Ayres 2002). Little else is known about reproductive biology, ecology, and demography of the species. (USFWS, 2019)

**Reproduction Narrative**

Adult: Senecio layneae is a perennial herb that flowers from April to July (California Native Plant Society 1994). Twenty-two plants from Cameron Park were used to determine whether the predominant breeding system was self-fertilizing or outcrossing (mating not involving inbreeding). Pollinators were excluded from the flower heads with fine mesh fabric. Open pollinated flower heads had an 8-fold increase in potentially viable seeds over flower heads where the pollinators had been excluded, indicating that the predominant breeding system for Senecio layneae is outcrossing (Marsh 2000) (USFWS, 2002).

**Habitat Type**

Adult: Chapparral (NatureServe, 2015)

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 2019)

**Habitat Narrative**

Adult: In addition to occurring on gabbro soils, Layne’s butterweed is also known to occur on serpentine soils.All serpentine sites, with the possible exception of the one in Shingle Springs, continue to support Layne’s butterweed. Persistence in at least two separate habitat/soil types benefits these species by increasing their degree of representation. (USFWS, 2019)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Stable to increasing (USFWS, 2019)

**Number of Populations:**

45 populations;  6 extant; 36 presumed extant; 3 possibly extirpated (USFWS, 2019)

**Population Size:**

Greater than 9,100 individuals (USFWS, 2019)

**Additional Population-level Information:**

The 1996 listing rule did not present information on the abundance of the gabbro plant species (Service 1996, p. entire). As summarized in the 2019 review, annual surveys were carried out for all five species at the Pine Hill Preserve from 2007–2009 (Service 2019, p. 9). The 2009 surveys at the Pine Hill Preserve estimated over 9,820 Stebbins' morning glory, 55,350 Pine Hill ceanothus, 104 Pine Hill flannelbush, 21,000 El Dorado bedstraw, and 9,100 Layne's butterweed (BLM 2010 as cited in Service 2019, p. 9). Current abundance estimates were not available for other populations of the gabbro plant species due to infrequent surveying especially on private lands (Service 2019, p. 9). Since the 2019 review, periodic surveys continue to be completed by BLM and species experts (Klip et al. 2020; Ayres et al. 2020). The Diversity Database shows that additional survey data from 2017–2018 has become available for a limited number of occurrences: three occurrences of Pine Hill ceanothus, seven occurrences of El Dorado bedstraw, and one occurrence of Layne's butterweed (Diversity Database 2023). Appendix A presents the number of plants observed during the most recent survey of each occurrence of the gabbro plant species as recorded in the Diversity Database. New abundance estimates for Pine Hill Preserve are only available for Pine Hill flannelbush which was estimated to be between 300–400 individuals on the Pine Hill Unit, based on surveys done in 2019 (Ayres et al. 2023b). This abundance estimate is three to four times greater than the 2009 estimate. This increase in the estimated abundance of Pine Hill flannelbush is likely due to increased survey effort at Pine Hill preserve including survey effort in areas along the permitter of the Pine Hill Preserve and other areas that had not been surveyed previously (Klip et al. 2020, p. 65; Ayers in litt. 2023b). While new population estimates for the other gabbro species on the Pine Hill Preserve are not available, botanical surveys were conducted around the perimeter of Pine Hill from 2017–2019 in areas that had not been previously surveyed (Klip et al. 2020, p. 59). These surveys recorded 10 new patches of Pine Hill ceanothus, 6 new individuals of Pine Hill flannelbush, 16 new patches of El Dorado bedstraw, and 15 new patches of Layne's butterweed on Pine Hill (Klip et al. 2020, p. 65). Additional Pine Hill flannelbush individuals were found during rare plant surveys in 2019 on Pine Hill itself; on the peak and the sunny, southern slopes of Pine Hill and areas along Pinehill Road (Ayers in litt. 2023b). The overall paucity of survey data for the five gabbro plant species limits our ability to assess population trends (USFWS, 2024).

**Population Narrative:**

In general, a direct comparison of species abundance now versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. However, given the increase in the number of populations of Layne's butterweed since listing, it is likely that overall abundance has increased for those species (CNDDB 2018). (USFWS, 2019). At the time of listing Stebbins' morning-glory, Pine Hill ceanothus, Pine Hill flannelbush, El Dorado bedstraw, and Layne's butterweed occurred primarily on the Pine Hill formation, an area of approximately 10,400 hectares (25,700 acres) in western El Dorado County, California, ranging in elevation from 138 to 628 meters (453 to 2,060 feet) (Service 1996, p. 54346). In addition, Stebbins' morning-glory and Layne's butterweed had "a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne counties" (Service 1996, p. 54346). Between the listing of the species and the 2019 review, additional occurrences were discovered or introduced outside of Pine Hill Preserve (Service 2019, p. 6). Most notably, a few occurrences of Stebbins' morning glory were identified in Nevada County near Grass Valley, two occurrences of Layne's butterweed were found in Yuba and Placer counties, and two additional occurrences of Layne's butterweed were identified in Tuolumne County (Service 2019, p. 6). The 2019 review also noted that occurrences of Pine Hill flannelbush (Diversity Database occurrences 8, 9, 13, 14, 15) had been recorded in Nevada and Yuba counties but that the species identification had not yet been verified (Service 2019, p. 6). Recent morphological studies suggest that the flannelbush plants in Nevada and Yuba counties are unique from Pine Hill flannelbush (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat loss and fragmentation (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

**Stressor:** Altered fire regime (USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for Layne's butterweed establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019a)

**Stressor:** Land use activities USFWS, 2002)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The increasing number of people and changes in land uses will continue to place an increasing strain on undeveloped areas through activities such as off-road vehicle traffic, unauthorized garbage dumping, and changes in the pattern of wildfires. Horse paddocking in rural residential areas within the central and northern portions of the Pine Hill formation

threatens this species. The horses, when confined, severely graze or trample most available vegetation. The herbaceous gabbro plants are especially likely to be grazed (J. Van Ess pers. comm. 1993). (USFWS, 2002)

**Stressor:** Invasive nonnative plants (USFWS, 2019)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). However, a population of Layne's butterweed at BLM's Red Hills Kanaka Point property in Tuolumne County is threatened by yellow starthistle (Centaurea solstitialis) and distaff thistle (Carthamus lanatus) (B. Brenneman, in litt. 2018b). (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**
Not applicable.

Recovery Priority Number: 5C

**Delisting Criteria:**
1. Secure and protect specified recovery areas from incompatible uses: Populations representing the range of the species including: (a) Cameron Park preserve south of Highway 50, (b)Cameron Park preserve north of Highway 50, (c) Pine Hill preserve, (d) Penny Lane preserve, (e) Salmon Falls/Martel Creek preserve, (f) occupied habitat on BLM lands in Yuba and Tuolumne Counties, and (g) occupied habitat on the Eldorado National Forest; along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all populations and any occupied or unoccupied habitat identified as necessary for survival and recovery (see previous column) (USFWS, 2002).

3. Monitoring in all recommended preserves shows: (a) Stable or increasing with evidence of natural recruitment for a period of 60 years that includes normal disturbance. (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be at least 10 percent greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats (see Appendix H); (aa) Study importance of fire for management; (b) seeds of disjunct populations stored in at least two Center for Plant Conservation certified facilities. (c) Maintain metapopulation dynamics of at least 1 very large, 1 large, 7 medium, and 24 small occurrences throughout the Pine Hill formation; of at least 1 large, 2 medium and 5 small in western El Dorado County; of at least 2 medium and 4 small in Tuolumne County; and of at least 2 small in Yuba County. (USFWS, 2002)

**Recovery Actions:**

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Serpentine soil areas off the Pine Hill formation in El Dorado County; Serpentine and Gabbro areas in Nevada County; Serpentine near Red Hills in Tuolumne . Reproduction and Demography Research: Including determining limiting life stages, seed production and survival in soil to determine appropriate fire return period, reproductive studies identifying pollinators, seed germination studies. . Genetics research. . Other Research Needs: Influence of disturbance and fire on seedling establishment; effects of grazing; metapopulation analysis; effects of fire; fire management techniques; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of

habitat restoration/ enhancement. . Management Actions Needed: Disturbance/ burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; seed banking for disjunct populations. (USFWS, 2002)

- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species.

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the gabbro plant species. Some of these recommendations have already been discussed in the recovery plan (Service 2002, pp. IV-1–IV22) and remain valid. All gabbro plant species 1. Further investigate the response of all five species to fire. Studies should focus on mortality, resprouting, and seedling recruitment following fire. 2. Dedicate more resources toward the investigation of best habitat management approaches for the gabbro plant species at the Pine Hill Preserve. Investigate fire-related and non-fire related methods of disturbance to maintain habitat for each of the gabbro plant species. a. Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined for each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for each species. (USFWS, 2024)

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# SPECIES ACCOUNT: *Sidalcea keckii* (Keck's Checker-mallow)

***Species Taxonomic and Listing Information***

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

**Physical Description**

A slender, bristly-hairy, annual herb, 1.5-3.5 dm tall. A few deep pink flowers bloom April-May. (NatureServe, 2015)

**Taxonomy**

A distinct species in a genus of about 22 species of western North America. (NatureServe, 2015)

**Historical Range**

At the time of listing, the Mine Hill Sidalcea keckii population existed within a 0.73 acre area. The population occurred on a privately owned 700-acre parcel of land that was used for livestock 5 grazing. The occurrence of S. keckii at Mine Hill in Tulare County may have been extirpated when orange groves were planted on the property. (USFWS, 2012)

**Current Range**

Tulare and Fresno counties (NatureServe, 2015)

**Critical Habitat Designated**

Yes; 3/18/2003.

**Legal Description**

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Sidalcea keckii (Keck's Checker-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (68 FR 12863-12880).

**Critical Habitat Designation**

The critical habitat designation for Sidalcea keckii includes three CHUs in Fresno and Tulare counties, California. This species critical habitat encompasses approximately 1,085 acres (ac) (438 hectares (ha)) (68 FR 12863-12880).

Unit 1: Piedra: Unit 1 is on the western slopes of Tivy Mountain in the Piedra area of southern Fresno County. It contains 206 ha (510 ac), of which 203 ha (503 ac) are privately owned and 3 ha (7 ac) are managed by the BOR (R. Faubion, pers. comm., 2002). Of the privately owned land, 77 ha (189 ac) of proposed critical habitat is on the Tivy Mountain Reserve which is owned by SFC and established for the conservation of Sidalcea keckii and other rare plants. SFC uses managed grazing as a tool to reduce competing non-native grasses from S. keckii sites, and monitors the plant as well (SFC 2001). Another 6.5 ha (16 ac) of this unit occurs on a conservation easement held by SFC on privately owned land adjacent to the reserve. Recent surveys of the areas containing documented populations of Sidalcea keckii were conducted in 1998, 2000, and 2001. In 1998, surveys coordinated by the BOR found 500 to 1,000 plants in the area (Cypher 1998). Surveys conducted in 2000 and 2001 by the SFC found eight separate patches of S. keckii growing on both Fancher and Cibo soils (C. Peck, in litt., 2002). This unit is essential to the conservation of the species because it is one of the two sites at which the species has been observed since the 1930s. When the number of populations or geographic distribution of a species are severely limited, as is the case when plants have only been observed recently at two locations, possible extinction or extirpation due to random events become a concern. Examples of random events that are a concern include fire and disease (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994). This unit is also essential because it includes the most northerly location known for S. keckii, and is the only location where above-ground plants with maroon-centered flowers have been documented (Cypher 1998).

Unit 2: Mine Hill: Unit 2 is about 3 km (2 mi) south of Success Dam and 5 km (3 mi) east of Porterville in Tulare County and contains 86 ha (213 ac), all of which are on privately owned land. Unit 2 encompasses a single known patch of Sidalcea keckii, which contained approximately 60 plants when last surveyed in 1992. At the request of the landowner, it has not been surveyed since that time. However, based on information from public comment, the standing population at Mine Hill may have been extirpated by conversion of the habitat to an orange grove. We currently do not know how much habitat may have been converted, although we believe that much of the habitat around the original population remains potentially viable and may contain a seed bank or standing plants. The Coarsegold rock outcrop soils of the area are best suited to rangeland (SCS 1982), which is the current use of the area where not converted to orchard. However the site is also zoned for mobile home development (R. Brady, Tulare County Planning Department, pers. comm., 1997). This unit is essential to the conservation of the species because it is presumably one of the two known locations where Sidalcea keckii plants have been observed since the 1930s. As is the case with Unit 1, when the number of populations or geographic distribution of a species are severely limited, possible extinction or extirpation due to random events become a concern. Examples of random events that are a concern include fire and disease (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994).

Unit 3: White River: Unit 3 is located near the town of White River in southern Tulare County. It contains 146 ha (362 ac), all of which is private land. Unit 3 contains the ‘‘type’’ location, specimens from which were used to first describe the species in 1940 (Wiggins 1940). This site is the only one not closely associated with serpentine rock, but contains the primary constituent elements that would support the species. This may be due to the presence of currently unknown and unmapped serpentine areas, or it may be due to an increased ability to compete on non-serpentine Cibo soils. As noted above, the White River site is one of the extremely few locations where Sidalcea keckii has ever been observed and may be occupied by a seed bank. Sidalcea keckii plants may still occur here, but none have been documented recently. Even if the species is not rediscovered at the White River site, we believe the site is essential to the conservation of the species. Because S. keckii has been observed at the site, it is the most appropriate site at which a reestablishment effort might be attempted. The combination of small range, few populations, and restricted habitat makes S. keckii susceptible to extinction or extirpation from a significant portion of its range due to random events, such as fire, disease, or other occurrences (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994). Such events are a concern when the number of populations or geographic distribution of a species are severely limited, as is the case with S. keckii. Establishment of a third location for S. keckii is likely to be an important component in reducing the risk of extinction due to such catastrophic events. This location also represents the southernmost extent of the known historical range of the species.

**Primary Constituent Elements/Physical or Biological Features**

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Sidalcea keckii critical habitat consists of two components (68 FR 12863-12880):

(i) Minimally shaded annual grasslands in the foothills of the Sierra Nevada Mountains containing open patches in which competing vegetation is relatively sparse; and

(ii) Serpentine soils or other soils that tend to restrict competing vegetation.

***Life History***

**Food/Nutrient Resources**

**Habitat Type**

Adult: Gressy slopes (Natureserve, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Serpentine soils (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: High (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Found on grassy slopes from 120 to 425 m elevation. The extant population is in a sparsely vegetation annual grassland on red or white-colored clay soils with 2-40 percent slopes. The clay substrates are thought to be derived from serpentine. (NatureServe, 2015)

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Population Growth Rate:**

Loss of populations because of development. Decline of 50-70% (NatureServe, 2015)

**Number of Populations:**

1 - 5 (NatureServe, 2015)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

Loss of populations because of development. Decline of 50-70% Known historically from 3 populations in Tulare and Fresno counties, California, but the species has potentially been extirpated from each location. A new location discovered in 1998 had approximately. 900 individuals. Historical occurrence at White River near Glenville, Tulare County, California. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and restricted habitat requirements.

***Threats and Stressors***

**Stressor:** Agricultural conversion (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Agricultural development is listed as a threat to this species (USFWS, 2012).

**Stressor:** Potential development (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Critical Habitat Unit KECK-1 includes 205 acres of land protected by the Sierra Foothill Conservancy, federally managed lands, and some private land. There is a single unprotected parcel within the Piedra population that could potentially be developed (Stebbins 2004). However, there are no imminent plans for development at this time. The Service is not aware of any activities that would have caused destruction or modification habitat within Critical Habitat Unit KECK-1 since the last 5-Year Review in 2007 (USFWS, 2012).

**Stressor:** Grazing (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** At the time of listing, cattle (Bos taurus) grazing was discussed as a potential threat to the species; there has been no known change since the final listing. Cattle grazing may limit encroachment of non-native grasses (C. Peck, in litt., 2002; Weiss 1999). However, cattle have been observed to cause damage to S. keckii by eating or trampling it, although the damage was barely noticeable a week later (Cypher 1998). Increased grazing during months of flowering, seed-set, or seed maturation could potentially reduce local population viability and negatively affect long-term conservation of this species. Summary of Factor C: Diseases do not appear to be a threat at this time. Overgrazing by cattle may threaten the long-term conservation of this species (USFWS, 2012).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Summary of Factor D: In summary, the Endangered Species Act is the primary Federal law that has provided protection for this species since the dates of its listing as endangered in

2000. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2012).

**Stressor:** Small population size (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Threat of extinction/lack of genetic variability
**Narrative:** Small population size increases the susceptibility of a population to extirpation from random demographic, environmental, and/or genetic events, affecting survival and reproduction of individuals (Shaffer 1981, 1987; Lande 1988; Groom et al. 2006). Small populations of annual species, such as Sidalcea keckii, may be more vulnerable to random environmental events such as extreme weather, disease, fire, or insect infestations (Shaffer 1981, 1987; Menges 1991; Groom et al 2006). For example, if a fire should occur before plants bloom or during the blooming season, the fire could destroy the individual plants as well as deplete the seed bank. The threat from random natural events has increased since S. keckii was listed because the plant now is found only at one location (USFWS, 2012).

**Stressor:** Altered fire regime (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** he absence of Sidalcea keckii from dense grasslands, even those on serpentine clay soils, suggests that it is a poor competitor (Stebbins 1992; J. Stebbins, pers. comm. 2001). Thus, aggressive, nonnative grasses such as Bromus madritensis ssp. rubens, and Bromus hordeaceus could potentially outcompete S. keckii if conditions changed to favor these grasses. For example, soil disturbances, increased availability of soil nutrients (e.g., nitrogen deposition) from cattle feces and other sources, and absence of fire may provide ideal conditions that would allow these nonnative grasses to outcompete S. keckii. Non-native grasses may generate increased fuel sources that could increase intensity of fires above the normal range of variability in serpentine grasslands that support S. keckii (E. Cypher, California Department of Fish and Game, pers. comm. 2006). However, an appropriate fire regime may reduce the presence of nonnative grasses and benefit serpentine endemic species such as S. keckii (Harrison et al. 2003) (USFWS, 2012).

**Stressor:** Climate change (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to

make accurate predictions regarding its effects to particular species at this time (USFWS, 2012).

***Recovery***

**Recovery Actions:**

- There is no approved final or draft recovery plan for the species (USFWS, 2012).
- Continue to protect property with suitable habitat for Sidalcea keckii. Acquisition of additional habitat through fee title or conservation easements is needed for the recovery of the species (USFWS, 2012).
- Survey additional serpentine and gabbro soil areas in Tulare and Fresno Counties to discover additional populations of Sidalcea keckii (USFWS, 2012).
- If additional populations of Sidalcea keckii are not discovered through systematic surveys, the species should be reintroduced into protected land within critical habitat units (USFWS, 2012).
- Continue monitoring the status and trend of Sidalcea keckii to determine whether this species is stable, increasing, or declining (USFWS, 2012).
- Continue genetic studies to confirm the species identity of plants preliminarily identified as Sidalcea keckii so that we can more accurately determine the actual number of populations, the geographic range, and types of habitats that support this species (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- The following recommendations for future actions are from the 2012 5-year review, scientific literature, and as a result of discussions with species experts. 1. Protect existing habitat in the San Joaquin Valley for Keck's checkermallow. 2. Conduct genetic evaluations to determine taxonomic status of Keck's checkermallow outside of the San Joaquin Valley. 3. Survey both extant and extirpated occurrences that have not been visited in the past few years to determine the status of these occurrences. Conduct yearly surveys at extant locations utilizing a standardized methodology to determine trends in the range-wide status as well as population/occurrence abundance. (USFWS, 2020)

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# SPECIES ACCOUNT: *Sidalcea oregana ssp. valida* (Kenwood Marsh checker-mallow)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/21/1997; Pacific Southwest (R8)

**Physical Description**

A perennial herb in the mallow family (Malvaceae). The plants are 1 to 2 m (3 to 6 ft) tall. The leaves are rounded. Lower leaves have 5 to 7 shallow lobes; upper leaves are generally smaller and divided into 3 to 5 entire, lanceolate segments. The compound inflorescence consists of densely flowered, spike-like racemes 2 to 5 cm (0.8 to 2.0 in) long. Petals are 1.0 to 1.5 cm (0.4 to 0.6 in) long, notched at the apex, and deep pink-mauve. The flowers appear from late June to September. Sidalcea oregana ssp. valida differs from S. oregana ssp. eximia in having a hairless calyx. (USFWS, 1997)

**Taxonomy**

Edward L. Greene (1897) first described Sidalcea oregana ssp. valida in June, 1894, based on material he collected from Knight's Valley, Sonoma County, California. Since then, this taxon has been known as S. maxima (Baker), S. oregana var. spicata (Jepson), S. eximia (Baker) and S. spicata ssp. valida (Wiggins) (CNPS 1988b). C. L. Hitchcock (1957) studied the genus Sidalcea and recognized four subspecies, including S. oregana ssp. valida, a treatment accepted by Steven Hill (1993). (USFWS, 1997)

**Historical Range**

See current range/distribution.

**Current Range**

Freshwater marshes approximately 150 m (490 ft) in elevation, at Kenwood Marsh and Knight's Valley, Sonoma County, California.  (USFWS, 1997)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Flowers appear from late June to September (USFWS, 2009).

**Reproduction Narrative**

Adult: Flowers appear from late June to September (USFWS, 2009).

**Habitat Type**

Adult: Marsh (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits the edges of freshwater marsh. (NatureServe, 2015). High ecological integrity of the communit and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the low number of known populations.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2019)

**Number of Populations:**

2 (USFWS, 2019)

**Population Size:**

Varies from 24 to 500 per population (USFWS, 2019). 157 total in 2023 (USFWS, 2024)

**Additional Population-level Information:**

At the time of listing, two occurrences of Kenwood Marsh checker-mallow were known to exist with 130 plants between them. In 2018, biologists observed a small population (less than 100 individuals) at Deerfield Ranch Winery but no abundance survey was done (K. Symonds, pers. comm. 2018). Based on new observations from scientists and volunteers the threats to Kenwood Marsh Checker-mallow have marginally increased since the last status review. However, there has been no change to our understanding of threats to the species, or its distribution. (USFWS, 2019). 157 total in 2023 (USFWS, 2024)

**Population Narrative:**

There are two locations with extana populations: Kenwood Marsh and Deerfield Ranch Winery. During the previous status review (2009) there were two main sites within Kenwood Marsh where the Kenwood Marsh checker-mallow remained extant: at Deerfield Ranch Winery and on an adjacent property. Today, the only confirmed, extant population exists at the Deerfield Ranch Winery. Botanists have not surveyed the additional population at Kenwood Marsh for nearly 20 years (Service 2009) and the status of the plant remains unknown at this location. Likewise, no botanical surveys have been done at Knight’s Valley in 30 years. In 2009, only three colonies existed at the Deerfield Ranch Winery (USFWS; A. Rex, in litt. 2017). Kenwood Marsh checker-mallow abundance at this location has continued to decline in recent years (A. Rex, in litt. 2017; Appendix A). Over the past 25 years, the abundance at the winery has fluctuated from as many as 550 individuals, to as few as 24 (Appendix B; CNDDB 2018; USFWS 2009). (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Grazing (USFWS, 1998)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** This species is adversely affected at both of its locations by reduced seed set resulting from cattle grazing (CNPS 1988b). Populations of Lilium pardalinum ssp. pitkinense have been enclosed with various types of wire fencing in an attempt to prevent grazing or browsing by cattle, horses, and deer, but most of the fences have failed to prevent grazing completely. The plants continue to suffer from herbivory by cattle, deer, and perhaps gophers and other herbivores, resulting in loss of flowers and seeds (L. Lozier, in litt. 1990). (USFWS, 1997)

**Stressor:** Water diversion (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Both permitted and unathorized water diversions are listed as a threat to this species (USFWS, 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Regulatory mechanisms are deemed as inadequate to protect this species. Including those that require a 10-day advance notice to officials before private landowners change the land use in areas populated with this species. (USFWS, 2009).

**Stressor:** Small population size (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The small population size of this plant species increases the susceptibility to extirpation from random events. Population sizes of 100 or fewer are known for one or more populations of Sidalcea oregana ssp. valida. This species may also be subject to increased genetic drift and inbreeding as a consequence of their small population sizes (Menges 1991, Ellstrand and Elam 1993). Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993). This species is threatened by potential loss of fitness and/or genetic variability associated with small population sizes. (USFWS, 1997)

**Stressor:** Naturally-occurring events (USFWS, 1997)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The potential for loss of the only population of Sidalcea oregana ssp. valida from naturally occurring events, because of the small population size, is exacerbated by drought and water diversions. In addition, this population is being encroached upon by invasive weeds, including yellow star-thistle and blackberry (A. Howald, pers. comm. 1993). One of the subpopulations was damaged by an off-road vehicle during maintenance of a local aqueduct, which passes through the marsh. The maintenance activity occurred late in the season when the soil was relatively dry, resulting in minimal damage to the plants. If such maintenance activities occur during a time when the soil is saturated, they pose a threat to the plants (A. Howald, pers. comm. 1993). (USFWS, 1997)

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is listed as threat to this species. (USWS, 2009)

***Recovery***

**Reclassification Criteria:**
Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

Recovery Priority Number: 3C

**Delisting Criteria:**
Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

**Recovery Actions:**
- Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)
- Removing thatch and invasive species from exclosures: Kenwood Marsh checker-mallows grow in full sun on the margins of riparian areas (K. Symonds, pers. comm. 2018). The species is currently threatened by thatch buildup from annual sedges, as well as invasive plants, both of which shade habitat (K. Symonds, pers. comm. 2018; R. Rex, pers. comm. 2018). Manual removal of invasive plants and thatch might be necessary to increase Kenwood Marsh checker-mallow survival. In 2018, Deerfield Ranch Winery staff and volunteers removed thatch and invasive plants from browsing exclosures (A. Rex, pers. comm. 2018). These efforts should take place annually to ensure the survival of Kenwood Marsh checker-mallow. (USFWS, 2019)
- Locate appropriate areas for new colony establishment: The Kenwood Marsh checker-mallow probably once existed in riparian zones between Kenwood Marsh and Knight's Valley. Today, the dispersal of this species is restricted by land-use conversion to agriculture and urban areas. However, there might be areas within the historical range where the species could be re-established with seeding and outplanting. Private landowners should be contacted and, if landowners are willing, a management plan should be developed and implemented by the Service or CDFW. Research and public outreach would be needed to determine the feasibility of establishing new colonies in the area. (USFWS, 2019)

- Population monitoring: Population estimates of Kenwood Marsh checker-mallow are sporadic (CNDDB; Appendix B). Establishing a protocol for continual, annual population monitoring would help us better understand the species needs and recovery potential. (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Kenwood Marsh checker-mallow. Some of these recommendations have already been discussed in the previous status review (Service 2019, p. 3) and remain valid. 1. Continue surveys and develop a management plan for all exclosures at the Deerfield Ranch Winery. a. Establish a protocol for annual population monitoring. b. Verify a permanent conservation easement is in place for the property. c. Create a management plan with the cooperation of the landowner, conservation managers, the Department, and the Service. d. Evaluate management plan and adapt as necessary. 2. Manage competing vegetation: a. Remove/reduce invasive blackberry and native willow in the Willow exclosure at the Deerfield Ranch Winery to support latent seed germination and maintenance of Kenwood Marsh checker-mallow habitat. b. Remove thatch and competing vegetation annually in the Road exclosure. 3. Monitor hydrology and restore historical hydrology to the remaining portions of Kenwood Marsh and Knights Valley. a. Collect data on current hydrological conditions and inter- and intra-annual fluctuations. Compare to historical data if available. Restore historical flow and saturation to provide suitable habitat for Kenwood Marsh checker-mallow. 4. Reattempt out-planting at the Deerfield Ranch Winery exclosures 3, 4, and Willow if removal of competing vegetation does not result in germination of seed from the soil seedbank. 5. Build communication with the landowners of the Kenwood Marsh-West and the Knights Valley localities to survey those sites, secure protection, and create management plans. 6. Create permanent conservation easements at sites where the Kenwood Marsh checkermallow is known to occur. 7. Identify and consider permanently protecting locations within the Kenwood Marsh checker-mallow's historical range that contain suitable habitats for future outplantings. 8. Attempt outplanting at new locations on private and public land within the Kenwood Marsh checker-mallow's historic range. (USFWS, 2024)

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# SPECIES ACCOUNT: *Sideroxylon reclinatum ssp. austrofloridense* (Everyglades bully)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

**Physical Description**

Everglades bully is a single to many-stemmed shrub, 3 to 6 feet (ft) (1 to 2 meters (m)) tall (Corogin and Judd 2014, pp. 410-412). The branches are smooth, slightly bent, and somewhat spiny. The leaves are thin, oval-shaped, 0.8 to 2 inches (in) (2 to 5 centimeters (cm)) long, evergreen, lance-shaped, and fuzzy on their undersides. The flowers are in axillary clusters. This subspecies is distinguished from the similar subspecies S. reclinatum ssp. reclinatum in Florida by its leaves, which are persistently pubescent (fuzzy) on their undersides, rather than smooth or pubescent only along the leaf midvein. In addition, the two subspecies are more reliably distinguished by differences in the micromorphology of the leaf epidermis. (USFWS, 2017)

**Taxonomy**

The genus Sideroxylon is represented by eight species in Florida. All of these plants were previously assigned to the genus Bumelia. Sideroxylon reclinatum, the Florida bully, is represented by three subspecies that range nearly throughout Florida and into neighboring states. The Everglades subspecies was first recognized by Whetstone (1985, pp. 544-547) as Bumelia reclinata var. austrofloridense, then transferred to the genus Sideroxylon (Kartesz and Gandhi 1990, pp. 421-427). Sideroxylon reclinatum ssp. austrofloridense was made a subspecies rather than a variety (Kartesz and Gandhi 1990, pp. 421-427); in plant nomenclature, the ranks of variety and subspecies are interchangeable. Sideroxylon reclinatum ssp. austrofloridense is used in the current treatment of the Florida flora (Wunderlin and Hansen 2016, p. 1). The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2016, p. 1), Integrated Taxonomic System (ITIS 2016, p. 1), NatureServe (2016, p. 1), and the Florida Department of Agriculture and Consumer Services (FDACS) (Coile and Garland 2003, p. 19) indicate that Sideroxylon reclinatum ssp. austrofloridense is the accepted taxonomic status. (USFWS, 2017)

**Historical Range**

The historical range of Sideroxlon reclinatum ssp. austrofloridense is limited to Collier, Miami-Dade, and Monroe Counties, Florida. In Miami-Dade County, the plant was known from central and southern Miami-Dade County along the Miami Rock Ridge, which extends from Long Pine Key in the Everglades northward through urban Miami to the Miami River. In Monroe County, the plant is known from Big Cypress National Preserve on the mainland, and was collected as far south as Key Largo, in the Florida Keys. In Collier County, the subspecies has been recorded only within Big Cypress National Preserve. The subspecies is apparently extirpated from Key Largo, and has not been found in surveys of pine rocklands on Key Largo, Big Pine Key, Cudjoe Key and Lower Sugarloaf Key. (USFWS, 2017)

**Current Range**

The current range of Sideroxylon reclinatum ssp. austrofloridense is in Miami-Dade and Monroe Counties, Florida, in Big Cypress National Preserve, the Long Pine Key region of Everglades National Park, and pine rocklands adjacent to Everglades National Park. The current range is approximately 42 mi (67.5 km). (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (USFWS, 2017)

**Reproduction Narrative**

Adult: Little is known about the life history of Sideroxylon reclinatum ssp. austrofloridense, including pollination biology, seed production, or dispersal. Reproduction is sexual, with new plants generated from seeds. The subspecies produces flowers from April to May, and fruit ripens from June to July. (USFWS, 2017)

**Habitat Type**

Adult: Pine rockland habitat, marl prairie habitat, and within the ecotone between both habitats (USFWS, 2017)

**Dependencies on Specific Environmental Elements**

Adult: Periodic fire is extremely important to maintaining habitat for this subspecies (USFWS, 2017)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2017)

**Tolerance Ranges/Thresholds**

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

**Dependency on Other Individuals or Species for Habitat**

Adult: The species frequently has numerous stem galls, but these galls do not appear to cause mortality to the plant and may in fact be an important part of the subspecies' natural history. In addition, the stem galls are often inhabited by acrobat ants. (USFWS, 2017)

**Habitat Narrative**

Adult: Sideroxylon reclinatum ssp. austrofloridense grows in pine rockland habitat, marl prairie habitat and within the ecotone between both habitats. These habitats are maintained by regular fire, and are prone, particularly marl prairie, to annual flooding for several months during the wet season. The species also grows on the sunny edges of rockland hammock habitat, which is fire-resistant. Everglades bully occurs in sparsely vegetated, well-lit, open areas that are maintained by disturbance. (USFWS, 2017)

***Dispersal/Migration***

**Dispersal**

Adult: Unknown (USFWS, 2017)

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2023)

**Number of Populations:**

14 extant populations (USFWS, 2023)

**Population Size:**

10,000 to 100,000 plants, mostly occurring at Long Pine Key (USFWS, 2023)

**Population Narrative:**

The largest population occurs at Long Pine Key in Everglades National Park (ENP). The population at Long Pine Key is estimated at between 10,000-100,000 plants. Recent surveys of ENP have identified 14 occurrences of Sideroxylon reclinatum ssp. austrofloridense in Long Pine Key, expanding the known range in ENP. In Miami-Dade County, outside ENP, pine rocklands tracts are orders of magnitude smaller and exist in a matrix of agricultural, commercial, and residential development. Approximately 73 plants were observed at Larry and Penny Thompson Park, within the Richmond Pine Rocklands. Extant populations have been found at Quail Roost Pineland (two plants), Navy Wells Pineland Preserve (four plants), and Sunny Palms Pinelands (two plants). The subspecies has been observed in pine rocklands at Grant Hammock and Pine Ridge Sanctuary. The subspecies no longer occurs at the Nixon-Smiley Preserve. Surveys in the Gum Slough region of Lostmans Pines in Big Cypress National Park reported finding Sideroxylon reclinatum ssp. austrofloridense with limited distribution within the study area (USFWS, 2017). The Everglades bully currently has 14 extant populations on public and private lands in Miami-Dade and Monroe counties (Table 1). There is evidence that populations of Everglades bully are increasing within Everglades National Park (Bradley et al. 2013; Gann 2015; Lange, pers. comm. 2017), but insufficient survey data on private lands coupled with persistent threats to the species means it is unclear whether the overall species status is trending upwards (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property

could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands.

**Stressor:** Inadequacy of Existing Regulatory Mechanisms
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

**Stressor:** Other Natural or Manmade Factors Affecting Its Continued Existence
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
Not defined.

Recovery Priority Number: 9

**Delisting Criteria:**
Not defined.

**Recovery Actions:**
- Recovery actions have not been defined.
- Conserve pine rocklands and suitable habitat through purchase or conservation easements.
- Provide regular prescribed burns to maintain suitable habitat conditions.
- Remove exotic plants and hardwoods to restore understories.
- Monitor and manage remaining small populations in Miami-Dade County.
- Locate new occurrences within Everglades National Park through additional surveys.
- Establish the limits of this species habitat requirements through additional surveys within Everglades National Park.
- Determine effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes through monitoring at Long Pine Key.

***Conservation Measures and Best Management Practices:***
- RECOMMENDED FUTURE ACTIVITIES Recovery Activities Through the course of this species status review, we recommend the following potential recovery activities. Restoration and protection of the pine rocklands, marl prairies, and rockland hardwood hammock habitats is critical to maintain populations of the species. This will ideally include increased fire management coupled with physical removal of invasive species. Removal of dense, woody invasive flora will prevent heightened burn temperatures and longer burn times, both of which increase Everglades bully mortality. More frequent prescribed fires will prevent tree encroachment and the succession of pine rockland habitat into hardwood forest. Further, we recommend working with private landowners to prevent the destruction of Everglades bully plants and to reintroduction. Monitoring / Research Activities We recommend extensive surveys on public and private lands to better understand the population trends in those areas. Of 14 extant populations, only the ENP colony has been sufficiently surveyed. There have also been no genetic studies on the Everglades bully, presenting a gap in our understanding of the species and its allelic richness. Further research should be conducted on the species response to development and fragmentation, pesticide use, and stochastic events and sea level rise which are expected to increase in frequency with climate change (USFWS, 2023)

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# SPECIES ACCOUNT: *Silene spaldingii* (Spalding's Catchfly)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

A perennial herb with stout stems, 2-8 dm tall. White flowers, forming a tight, leafy flower head, bloom from late June to August. (NatureServe, 2015)

**Taxonomy**

Spalding’s catchfly produce one to several vegetative or flowering stems that arise from a simple or branched persistent underground stem (caudex), which surmounts a long, narrow taproot. Plants range from 20 to 40 cm in height. Each stem typically bears 4 to 7 pairs of simple, opposite leaves that are 5 to 8 cm in length and 2 to 4 cm in width. Similar to the majority of plants in this family, Spalding’s catchfly has distinctly swollen nodes located where the leaves are attached to the stem. Reproductive individuals produce 3 to 20 cream to pink or light green flowers that are borne in a branched, terminal inflorescence. All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name ‘catchfly’ (USFWS, 2016).

**Current Range**

Regional endemic restricted to remnants of the Poulouse Prairie grasslands of eastern Washington, northeastern Oregon, northern Idaho, and western Montana (barely extending into British Columbia, Canada) (NatureServe, 2015). The species is endemic to the Palouse region of south-east Washington and adjacent Oregon and Idaho, and is disjunct in northwestern Montana and British Columbia, Canada (USFWS, 2016).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food/Nutrient Narrative**

Adult: All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name ‘catchfly’ (USFWS, 2016).

**Breeding Season**

Adult: Flowering typically occurs from mid-July through August, but may occasionally continue into October (USFWS, 2016).

**Reproduction Narrative**

Adult: Plants (both vegetative and reproductive) emerge in mid- to late May. Flowering typically occurs from mid-July through August, but may occasionally continue into October. Rosettes are formed the first and possibly the second year, followed by the formation of vegetative stems.

Above-ground vegetation dies back at the end of the growing season and plants either emerge in the spring or remain dormant below ground for one to several consecutive years. Spalding's catchfly reproduces solely by seed. It lacks rhizomes or other means of reproducing vegetatively (USFWS, 2016). Silene spaldingii is a partially self-compatible, hermaphroditic perennial. Reproduction is apparently via seed only, as rhizomes or other means of vegetative propagation are lacking. Seeds appear to require cold stratification, so germination occurs mainly in the spring. Rosettes are formed the first year and flowering may occur during or after the second season. Flowers are protandrous (Lesica and Heidel 1996). Anthers mature and dehise pollen first. During this time, the styles are unexpanded, and the unexposed stigmatic surfaces are held well below the level of the anthers. After the anthers shrivel and fall from the filaments, the three styles expand and the stigmas become receptive. Each flower persists for two to several days, and two or more flowers may be in bloom on the same plant, so geitonogamous pollination is possible. This system promotes outcrossing while allowing the possibility of self-pollination (Lesica 1991; 1993). The bumblebee, Bombus fervidus, appears to be the only significant pollination vector for S. spaldingii throughout its range (Lesica and Heidel 1996). At least at some populations, S. spaldingii appears to be subject to pollinator limitations, inbreeding depression, and a large genetic load (Lesica 1991; 1993).; Silene spaldingii most frequently occurs in relatively intact climax or successionally advanced mesic grassland communities (Lorain 1991). It does not occur at sites where the native vegetation has been displaced by aggressive weeds. It is apparently tolerant of light to moderate grazing (Schassberger 1988). In areas where grazing occurs, it does not appear to be preferred by cattle, but these populations also are much smaller than those in mature grassland habitats. Lesica (1994) found that prescribed burning at a site in Montana increased growth, recruitment and flowering of Silene spaldingii.; Perfect; Predominantly outcrossing; SEXUAL; ABIOTIC; Self-dispersing; Hymenoptera; (NatureServe, 2015)

**Habitat Type**

Adult: Palouse Prairie (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: The 2007 Recovery Plan describes occupied habitat within five physiographic regions; 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in eastern Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and 5) the Intermontane Valleys of northwestern Montana. These regions are distinctive from one another in climate, plant composition, historical fire frequencies, and soil characteristics. These differences are significant in that they may translate into differences in life histories, habitat trends, consequences of fire suppression, and types of weed control as they apply to conservation of catchfly (USFWS, 2016). Restricted to Palouse Prairies, sometimes extending into areas where the grasslands are intermingled with ponderosa pine (Pinus ponderosa) woodlands. Soils are almost always a productive, deep loess. Elevation range is 580-1,220 m. Silene spaldingii is restricted to Festuca idahoensis habitat types and phases throughout its range. These areas are often referred to as Palouse prairie. Sites are often near lower treeline, or near scattered ponderosa pine trees. Populations have been found on all aspects, but there seems to be a preference for northerly-facing aspects. It occurs at elevations ranging from about

1,900 to 3,600 feet, and on flat to steep slopes. Soils are almost always productive silt/loams (loess) that are moderately deep and sometimes gravelly (Gamon 1991; Lorain 1991). The soils are depositional materials from catastrophic floods of glacial Lake Missoula that extend from Montana across Idaho into eastern Oregon and Washington. (NatureServe, 2015)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

~109 (USFWS, 2020)

**Population Size:**

~110,313 (USFWS, 2020)

**Population Narrative:**

At the time the Recovery Plan was developed in 2007, 99 populations of Spalding’s catchfly were reported (22 populations in Idaho, 11 in Montana, 17 in Oregon, 49 in Washington). The last 5-year review (2009) reported 10 new populations, adding 3 in Idaho, 2 in Oregon, and 5 in Washington, bringing the total number of populations to 109, with an estimated rangewide number of individual plants being just under 30,000. As noted above, Spalding’s catchfly also barely extends in to British Columbia, Canada. Photo credit: Jannis Jocius, Population Census at Wallowa Lake KCA. However, as this Recovery Plan applies only to populations within Idaho, Montana, Oregon and Washington, occurrences in British Columbia are not reported in this review. The number of known occurrences of Spalding’s catchfly has increased since 2009. We have evaluated new occurrences provided to us by the Idaho Fish and Wildlife Information System (IFWIS) database and additional reports from Idaho (Pekas et al. 2019 and Gray et al. 2010); the Montana Natural Heritage Program database; the Oregon Fish and Wildlife Office (OFWO) as adapted from the Oregon Biodiversity Information Center (ORBIC) database, and the Washington Natural Heritage Program database. Currently there are 139 occurrences in the United States: 49 in Idaho, 76 in Montana, 49 in Oregon, and 50 in Washington. The number of individual plants in each population ranged from one to thousands with the estimated total number of plants rangewide being approximately 110,313 individuals (8,142 in Idaho, 20,874 in Montana, 56,379 in Oregon, 24,918 in Washington). However, total plant counts are only rough estimates (unless noted otherwise). Exact plant counts are difficult because observed populations fluctuate drastically from one growing season to another, Spalding’s catchfly individuals can remain dormant or appear aboveground only briefly for one or more consecutive years, some plant counts at EOs only represent a portion of the occurrence, not all occurrence data includes a population census count, and at some occurrences plant counts are fairly dated. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Human development (habitat loss) is listed as a threat to this species (USFWS, 2016).

**Stressor:** Grazing (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Habitat degradation
**Narrative:** Habitat degradation associated with adverse grazing and trampling by domestic livestock and wildlife is listed as a threat to this species (USFWS, 2016).

**Stressor:** Nonnative plants (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Invasions of aggressive nonnative plants are listed as threats to this species (USFWS, 2016).

**Stressor:** Loss of genetic variability (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Extinction/loss of genetic variability
**Narrative:** Loss of genetic fitness (the loss of genetic variability and effects of inbreeding) is a problem for many small, fragmented populations where genetic exchange is limited (USFWS, 2016).

**Stressor:** Fire frequency and seasonality (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Fire frequency and seasonality is listed as a threat to this species (USFWS, 2016).

**Stressor:** Off-road vehicle use (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals/habitat degradation
**Narrative:** Off-road vehicle use is listed as a threat to this species (USFWS, 2016).

**Stressor:** Herbicides (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Herbicide spraying and drift is listed as a threat to this species (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8C

**Recovery Actions:**

- Ongoing conservation efforts include research, Palouse Grassland conservation actions, invasive nonnative plant control, and land acquisition. Monitoring efforts continue, the technical team has worked towards developing a standardized monitoring protocol, and new monitoring has been initiated (USFWS, 2016).

***Conservation Measures and Best Management Practices:***

- Recommendations for Future Actions: The many conservation activities on-going for Spalding's catchfly should continue: • Continue working as a Technical Team to collaborate on recovery actions for this species, particularly at the KCAs. • Continue to pursue additional partnerships at areas identified as having potential to be KCAs. • Continue outplanting efforts in order to increase population numbers at KCAs with less than 500 plants (which includes investing in seed increase and grow-out of Spalding's catchfly plants and studying techniques such as direct seeding and site preparation techniques). • Continue the range-wide monitoring program at each of the KCAs and periodically analyze data sets. • Continue survey efforts to locate potential new populations or document population expansions at known locations. In addition to continuing those efforts, the following recovery actions should be made a priority (for funding and implementation) over the next 5 years: • Initiate development of Spalding's catchfly Habitat Management Plans at KCAs that currently are not covered. • Monitor, manage, and evaluate the response of Spalding's catchfly to site-specific stressors at KCAs, such as livestock, rodent activity, and insect herbivory; fire; potential loss of pollinators, and invasive nonnative plant species. • Prioritize the collection of quantitative invasive nonnative plant cover within KCAs. • Complete long-term seed banking at KCAs as well as smaller populations in order to preserve the breadth of genetic material across the species' range. (USFWS, 2020)

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# SPECIES ACCOUNT: *Solidago houghtonii* (Houghton's goldenrod)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** HOGO

**Listing Status:** Threatened; 07/18/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

**Physical Description**

A perennial herb. Stems are frequently tufted or clumped, up to 7.5 dm high. Leaves become linear upwards on the stems. The inflorescence is a terminal, more-or-less flat-topped cluster of relatively few, large flower heads, each consisting of about 6-9 pale to bright yellow ray flowers and several yellow disk flowers. The branches of the inflorescence are smooth, but the stalks of the flower heads are finely but distinctly hairy. Blooms in August. (NatureServe, 2015)

**Taxonomy**

FNA (vol. 20, 2006) transfers Oligoneuron houghtonii to Solidago houghtonii. The disagreements concerning the origin of S. houghtonii and, more importantly, the true identities of populations within the currently circumscribed range, argue strongly for considering the species in the broad sense now (USFWS, 1997; NatureServe, 2015)

**Current Range**

Solidago houghtonii is primarily an endemic of the Upper Great Lakes region, occurring principally on the northern shores of Lakes Michigan and Huron in Michigan and Ontario; peripheral range extends north to Canadian shores of Georgian Bay, also 1 disjunct site in New York. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Dependency on Other Individuals or Species**

Adult: Jolls' preliminary findings from the 1993 research indicate that S. houghtonii is self-incompatible and thus dependent on insect vectors for successful pollination. Potential pollen vectors include bees (Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). (USFWS, 1997)

**Breeding Season**

Adult: August to October (USFWS, 1997)

**Reproduction Narrative**

Adult: Flowering occurs primarily in August and early September but may occur as early as late July and not uncommonly well into October. Fruiting and seed dispersal appears to occur mostly from August through November and undoubtedly later (MNH 1993). Jolls' preliminary findings from the 1993 research indicate that S. houghtonii is self-incompatible and thus dependent on insect vectors for successful pollination. Potential pollen vectors include bees (Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). (USFWS, 1997)

**Habitat Type**

Adult: Terrestrial and palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Bog/fen, herbaceous wetland, riparian, barrens, sand/dune (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Prefers cool, moist areas (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Found in sparsely vegetated areas at elevations between 100 and 400 m (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Medium (USFWS, 1997)

**Habitat Narrative**

Adult: Solidago houghtonii occurs primarily along the northern shores of Lakes Huron and Michigan and is restricted to calcareous beach sands, rocky and cobbly shores, beach flats, edges of marl ponds, and especially the shallow, trough-like interdunal wetlands that parallel shoreline areas (MNEI 1993). Much less commonly, S. houghtonii occurs in wet prairie-like habitats in Lower Michigan and locally in a New York marl fen. It also occurs on seasonally wet limestone pavement, which is the species’ more typical habitat in the eastern portion of its range. S. houghtonii was collected from open limestone pavements in moist rock crevices (D.F. Brunton 3352, CAN). In sand dune areas, it tends to occur on the lee side of low foredunes and on low stabilized dunes adjacent to interdunal wetlands, especially in moist to saturated sands within and around interdunal depressions. The restriction of S. houghtonii to calcareous sands and dolomitic limestone areas of the Niagaran Escarpment suggests that the species requires a relatively high amount of calcium and magnesium (and possibly sodium and potassium) in its substrate. Dune sands in the region of the Niagaran Escarpment generally have a calcareous component of about 1 to 5 percent that is composed primarily of ground mollusk shells (Collins 1989). The sands in which it grows are circumneutral (pH 7.0) to alkaline (pH 8.0) and may occasionally have a thin covering of organic material (Collins 1989). Solidago houghtonii usually occurs where there is a relatively low density of competing vegetation at elevations between 100 and 400 meters. The species’ apparent establishment in the better drained portions of dunes, such as along the backside of foredunes, may indicate it has some resistance to desiccation. Often associated with Solidago ohioensis, Lobelia kalmii, and other calciphiles; occasionally associated with two other rare species: Pitcher's thistle (Cirsium pitcherii) and dwarf lake iris (Iris lacustris). (USFWS, 1997; NatureServe, 2015)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Fruiting and seed dispersal appears to occur mostly from August through November and undoubtedly later (MNH 1993). In researching the ecology of S. shortii, Buchel6 et al. (1991) found their data suggested no persistent seed bank for the species. In examining numerous other studies concerning the phenology of Solidago seed dispersal and germination, they concluded there is a good possibility that members of this genus produce seeds that remain viable for no more than one year, resulting in transient seed banks. (USFWS, 1997)

***Population Information and Trends***

**Population Trends:**

Unknown. Inferred from information (USFWS, 2020)

**Species Trends:**

Unknown. Inferred from information (USFWS, 2020)

**Population Growth Rate:**

Slowly declining (NatureServe, 2015)

**Number of Populations:**

~90 (NatureServe, 2015)

**Population Narrative:**

Long-term population trends suggest declines of 30-70%, whereas short-term trends indicate a decline of <30% to relatively stable. There are approximately 90 occurrences known (Penskar et al. 1996). (NatureServe, 2015). Recent status assessment efforts for a portion of the U.S. populations (45 out of 76 EOs) show many (28 out of 45) stable or increasing HOGO populations, with several locations having well over 10,000 flowering individuals (Leopold and Weber 2019). However, high lake levels, shoreline development, invasive plant species, recreation, and deer browse represent stressors to HOGO that need further evaluation (Leopold and Weber 2019) (USFWS, 2020).

***Threats and Stressors***

**Stressor:** Narrow habitat range (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Solidago houghtonii, like several of its associated endemics, is particularly vulnerable to extirpation because of its restriction to narrow shoreline habitats ofthe Great Lakes. In a 1981 status survey, D.C. Nepstad considered habitat destruction to be the greatest threat to populations of S. houghtonii and cited the desirability of shoreline areas for residential housing and the escalating pressure for this type of development as a principal cause of this habitat destruction. The rate of residential development continues to accelerate, and it is highly unlikely that there will be any abatement of this trend in the near future. Nepstad (1981) also noted that some major occurrences of S. houghtonii have been considerably altered and fragmented by private development such that their long-term viability has been severely diminished. This has

been a view supported by subsequent field surveys (MNFI 1993).There are many causes of habitat alterations that have adversely affected S. houghtonii populations. Construction of beach retaining walls and other emergency erosion control measures (e.g. rip-rap and bulkhead installation) prevents or inhibits dune formation. Excessive foot and off-road vehicle (ORV) traffic destabilizes dune and beach flats. Marina construction, road construction, sand mining, and home and cottage construction where improved lake views are desired, have resulted in leveling of dune ridges (Collins 1989). Driveway installation or permitted work performed by utilities and railroads near interdunal wetlands have fragmented colonies and altered the hydrology. Residential development further potentially threatens habitat by altering hydrology with the placement and construction of septic systems whose nutrient loading degrade adjacent interdunal wetlands. Finally, both foot and ORV traffic have caused the direct destruction of plants. (USFWS, 1997)

**Stressor:** Modification of groundwater (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Disjunct populations, located in calcareous fens and dependent upon calcium rich groundwater flowing through them, face additional threats. Modifications or contamination of the groundwater could cause these sites to become unsuitable for Houghton's goldenrod and could lead to extirpation of this species. As such, this species could be also be threatened by off-site activities. (USFWS, 2011)

**Stressor:** Invasive species (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Invasive species control efforts are underway in three of the four Michigan State Parks with Houghton's goldenrod. New York has had limited success with control efforts at Bergen Swamp. Common reed grass (Phragmites australis) is the non-native invasive species most likely to affect Houghton's goldenrod at Bergen Swamp (Drake, pers. comm. 2010), although encroachment by false brome (Brachypodium sylvaticum) may pose a threat to Houghton's goldenrod also (Steve Young, NYNHP, pers. comm., 2010). Almost all occurrences are threatened by the increase in invasive plant species, such as baby's breath (Gypsophila paniculata), Phragmites australis, purple loosestrife (Lythrum salicaria) and false brome (Brachypodium sylvaticum). If not removed or controlled, these invasive species may threaten the Houghton's goldenrod habitat by outcompeting native species, shading the habitat or altering the hydrology. (USFWS, 2011)

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change models predict the climate of the Great Lakes region will grow warmer and drier over the next century, with precipitation increasing in winter and decreasing in summer (AMEC 2006; Anton Reznicek, University of Michigan, pers. comm. 2004; Kling et al. 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10–20

percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling et al. 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling et al. 2003). Increased water temperatures will also result in decreased ice cover that when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000; AMEC 2006), altering Houghton's goldenrod habitat. A warmer climate could also bring about a northward shift and an even greater increase in invasive species that may be more problematic in the dunes and lakeshore systems, thus increasing competition with native plant species (Malcolm et al. 2002; AMEC 2006; Penskar, pers. comm. 2009). (USFWS, 2011)

**Stressor:** Roads and highways (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Several S. houghtonii occurrences in Michigan are within or along rights-of-way administered by MDOT. Records in the MNFI show that there are at least 11 occurrences partially within or along MDOT rights-of-way, representing nearly 20 percent of the known occurrences in Michigan. Kim D. Herman (1988) notes that S. houghtonii is more vulnerable to disturbance than two other endemics of Great Lakes shorelines, dwarf lake iris and Pitcher's thistle, because of its restriction to narrow bands of interdunal wetland habitats, many of which occur between coastal roads and lakeshores. In some of these sites, highways may be severely fragmenting S. houghtonii populations or preventing them from expanding and colonizing suitable habitat available further inland. Herman (1988) further states that the MDOT activities which resulted in the most adverse effects to this species and other Great Lakes endemics are projects along two major State roadways, US-2 and US-23, located in the Upper Peninsula and Lower Peninsula, respectively. These activities included culvert extensions, pavement recycling, shoulder widening, and other types of safety work. (USFWS, 1997)

**Stressor:** Road maintenance (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A number of common road maintenance activities, including emergency repairs on eroding shoreline areas, herbicide application, mowing, road salting, shoulder grading, snow removal, and tree removal, have affected populations of S. houghtonii (Herman 1988). A number of illegal activities which have occurred on or near MDOT rights-of-way have also affected this species and its habitat. Illegal use of sites by commercial fishermen and encroachments by ORV operators and other recreationists have had adverse effects (MNFI 1993). (USFWS, 1997)

**Stressor:** Off-road vehicles (ORVs) (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat damage resulting from ORV traffic is one of the major threats to S. houghtonii. The restriction of this species to a very limited, narrow expanse of shoreline habitat renders it particularly vulnerable to destruction and habitat fragmentation. Off-road-vehicles are in

widespread use and are very difficult to exclude from most kinds of natural areas, particularly beaches and coastal dunes. Their use and resulting effects on these sites are well documented throughout Michigan (MNFI 1993). Off-road-vehicle traffic or evidence of it has been observed in areas of exemplary S. houghtonii occurrences, such as Crow River Mouth (Mackinac County), Grass Bay (Cheboygan County), and Wilderness State Park (Emmet County) (MNFI 1993), and probably occurs in many and perhaps most other sites throughout the range of the species. (USFWS, 1997)

**Stressor:** Natural disturbances (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The restriction of S. houghtonii to low-lying, linear coastal zone habitats also causes it to be highly susceptible to natural disturbance. Rises in lake levels, such as the record highs attained in 1986, may severely reduce population numbers throughout the entire range of the species (Voss 1987). It is thus very important that destructive human activities are minimized or eliminated so as not to exacerbate the effects of natural disturbance (Voss 1987). (USFWS, 1997)

**Stressor:** Artificial stabilization of lake levels (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** It is unlikely that the range of S. houghronii will expand because of the accelerating habitat loss and fragmentation due to development, increasing human-caused habitat disturbance, and the restriction of nearly all individuals of the species to shores of the Great Lakes. Therefore, essential habitat must be protected. Any artificial stabilization of Great Lakes levels could markedly change the natural dynamics of shoreline habitats and be highly detrimental to S. houghtonii, as well as to many other sensitive species and significant natural communities. Stabilization of the Great Lakes at low water levels might initially benefit S. houghtonii by temporarily exposing maximum suitable habitat. However, unless lake levels are continually lowered, stabilized S. houghtonii habitat is likely to be altered and will become unsuitable through plant succession. As a relatively poor competitor restricted to dynamic shoreline areas, this species depends on the cyclical fluctuations of the Great Lakes. It suffers local extirpations during high water years, but later exploits and colonizes newly exposed habitat as it becomes available again. (USFWS, 1997)

**Stressor:** Over-collection (USFWS, 1997)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Like many rare species, S. houghtonii can potentially be over-collected by individuals with legal collecting permits, such as those who desire specimens for herbaria in which this taxon is poorly represented. Despite the good intentions of removing live plants for propagation and exhibition in rare plant collections, such activities, if done excessively or without proper permits, also represent a threat to populations. Permits granted for the taking of this species should be issued only after careful consideration and consultation with appropriate, knowledgeable individuals. Permits should stipulate that collections may be made only when an occurrence (i.e., a “population’.’) would not be significantly diminished or adversely affected by removal of

individuals. (USFWS, 1997)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 8C

**Delisting Criteria:**
1. Protect a minimum of 30 of the most viable occurrences of Houghton’s goldenrod and preserve the species’ essential habitat and the natural environmental processes that maintain it. (USFWS, 1997)

**Recovery Actions:**
- Protect all known occurrences, with priority given to the most viable occurrences and the species’ essential habitat. (USFWS, 1997)
- Survey suitable habitat for additional occurrences and verify the status of historic occurrences. (USFWS, 1997)
- Educate and notify land managers and the public. (USFWS, 1997)
- Monitor occurrences for population demographics, viability, and threats. (USFWS, 1997)
- Conduct biosystematic research throughout the species’ range. (USFWS, 1997)
- Report survey results and habitat and population conditions to the Michigan Natural Features Inventory and the East Lansing Field Office and update element occurrence records. (USFWS, 2011)
- Plan and implement regular surveys and monitoring of occurrences, including better documentation of habitat conditions and populations trends. (USFWS, 2011)
- Reassess ranks of known occurrences. (USFWS, 2011)
- Provide education and outreach to stakeholders and the public. (USFWS, 2011)
- Monitor approach of non-native species and control as appropriate. (USFWS, 2011)

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS: • Conduct a Species Status Assessment to inform the next 5-year review • Develop written agreements and management plans for protection on public lands (Recovery plan task: 1.12) • Plan and implement regular surveys and monitoring of occurrences, including better documentation of habitat conditions and populations trends. (Recovery plan tasks: 2.22, 4) o In particular, surveys are needed for sites not visited in 2015-2016 in Michigan. Information on the Ontario populations would also be helpful in evaluating the species’ status. • Reassess ranks of known occurrences. (Recovery plan task: 2.24) • Promote landowner involvement in a registry program. (Recovery plan task: 14.143) • Develop strategies to protect occurrences and sites from ORV damage. (Recovery plan task: 13.131) (USFWS, 2020)

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# SPECIES ACCOUNT: *Solidago shortii* (Short's goldenrod)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 9/5/1985; Southeast Region (Region 4) (USFWS, 2016)

**Physical Description**

A perennial herb with one to several erect or ascending stems 0.5 to 1.3 m tall, arising from a creeping rhizome. Stems are terete in cross section, slightly ribbed, and minutely scabrid-puberulent at least above the middle. Leaves are alternate, crowded, 5-10 cm long and 0.6 to 1.5 cm wide. Individual leaves are firm, oblong-lanceolate to narrowly elliptic, remotely serrulate and glabrous on both sides. The leaves are largest near the middle of the stem and become progressively smaller towards the inflorescence. Lower leaves are reduced and usually absent during flowering time. The inflorescence is terminal and ranges from racemose to paniculate with divergent, secund branches. Heads are 10-14 flowered on puberulent stalks usually 5 mm or less in length. The involucre is 4-6 mm long and 3 mm wide with imbricate, coriacious and glabrous phyllaries. Ray florets number from 4 to 8 and are 2.5-3.0 mm long. The corollas are elliptic-linear with bright yellow ligules about 2 mm long. The disc florets are also bright yellow with a short tube, funnel form throat and five linear spreading lobes about equaling the throat in length. The white papus is capillary and about 2 mm long. Achenes are cuneate-cylindric, about 2 mm long, and pale brown with appressed, silky pubescence (USFWS, 1988).

**Taxonomy**

In the Aster family (Asteraceae)(USFWS, 1988).

**Historical Range**

Historically known from Jefferson, Robertson, Nicholas, and Fleming Counties in Kentucky (USFWS, 1988).

**Current Range**

Known from Robertson, Nicholas, and Fleming Counties in Kentucky (the vicinity of Blue Licks, Kentucky) and along the Blue River in Harrison County, Indiana (USFWS, 2007).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect (USFWS, 1988)

**Breeding Season**

Adult: Flowers from mid-August to early November (USFWS, 1988).

**Key Resources Needed for Breeding**

Adult: Insects for pollination, probably bees (USFWS, 1988)

**Reproduction Narrative**

Adult: Flowers from mid-August to early November, and fruits mature several weeks after the flowers whither. Specific pollinators have not been documented; sweat bees have been observed visiting the flowers. Germination rates in the field are unknown (USFWS, 1988).

**Habitat Type**

Adult: Terrestrial (USFWS, 1988)

**Habitat Vegetation or Surface Water Classification**

Adult: A variety of dry, mostly open habitats, in full sun or partial shade (USFWS, 1988).

**Dependencies on Specific Environmental Elements**

Adult: Natural disturbance (USFWS, 1988)

**Environmental Specificity**

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

**Habitat Narrative**

Adult: Habitat is full sun or partial shade in a variety of dry, mostly open habitats. These include limestone cedar glades, open eroded areas, edges of dry, open oak-hickory woods, cedar thickets, pastures, old fields, power rights-of-way, and rock ledges along highway rights-of -way. This species does not appear to compete well and does best in areas with a low density of other plants. It will not grow in full shade (as in closed canopy woods). Soils are described as flaggy, silty clay texture with 20-30% rock fragments, and slightly acid to moderately alkaline, with slow permeability and rapid runoff (USFWS, 1988). In the long term, it appears that the species can survive only in early successional, short-term habitats (resulting from some disturbance), natural openings associated with animal movements or rock outcrops, or dynamic rocky shorelines along rivers (Indiana occurrence) (USFWS, 2007).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Although goldenrod fruits are normally wind dispersed, there is no evidence that this species is expanding its range by this method. It has been suggested that bison may be a dispersal vector (USFWS, 1988).

***Population Information and Trends***

**Population Trends:**

Stable to declining (USFWS, 2007)

**Species Trends:**

Decline of 10-30% (NatureServe, 2015)

**Number of Populations:**

20 (USFWS, 2023)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Adaptability:**

The plant is clonal and is capable of persisting after some disturbance. Survivorship curves are typical of other herbaceous perennials (Walck et al. 1999b). Does not produce a long-lived seed bank (Walck et al. 1999a) (NatureServe, 2015).

**Population Narrative:**

Based on the results of numerous surveys and investigations over the past 25 years, the current distribution of S. shortii is restricted to 13 occurrences within a 2-mile radius of Blue Licks Battlefield State Resort Park in Fleming, Nicholas, and Robertson counties, Kentucky and one occurrence along the Blue River in Harrison County, Indiana (Harrison-Crawford State Forest). Despite numerous, intensive searches of similar habitats, only two occurrences (one within Sho1i's Goldenrod SNP in Fleming County, Kentucky and the Indiana occurrence) have been discovered since completion of the recovery plan in 1988. At present, eight Kentucky occurrences (numbers 1, 2, 5, 7a, Sa, 11, 12a, and Short's Goldenrod SNP) and the Indiana occurrence appear to be stable, and some level of protection has been achieved for all but one of these occurrences (number 11). The remaining Kentucky occurrences have shown declines in the number of stems and surface area since 1989 (Smith et al. 2004; Buchele et al. 1989). The reason for these declines is unknown, but competition from exotics and land-clearing activities on private property appear to be the primary causes (USFWS, 2007). Currently, the species is known from 20 extant occurrences, including 12 Blue Licks occurrences (two occurrences are now considered extirpated); 3 introduced occurrences near Claysville in Harrison County, Kentucky; 1 introduced occurrence along the Licking River in Robertson County, Kentucky; 3 introduced occurrences at Clay Wildlife Management Area in Fleming and Nicholas counties, Kentucky; and 1 occurrence along the Blue River, Greenbrier Knob Nature Preserve, in Harrison County, Indiana (Homoya and Abrell 2005) (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Kentucky occurrences are most threatened by competition from exotics such as crown vetch, tall fescue, and other species described above, habitat disturbance on private property, and highway and powerline maintenance activities. The Indiana occurrence is most threatened by competition from exotics. The potential raising of the Ohio River's pool level is a possible threat but is unlikely to occur (USFWS, 2007).

**Stressor:** Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Recent park improvements in Blue Licks Battlefield State Resort Park are expected to increase the recreational use of the park and could lead to adverse impacts to S. shortii individuals if recreational activities (e.g., hiking) are not directed away from S. shortii occurrences. The species' small range and low number of individual plants makes it vulnerable to overcollecting for scientific purposes. Plants within Blue Licks Battlefield State Resort Park cannot be collected without a permit from the Kentucky Department of Parks and KSNPC; these permits are only issued for valid scientific purposes. Plants occurring on private property are not afforded this protection. The Indiana occurrence is also potentially threatened by recreational use (trampling by fishermen, canoeists, hikers). At present, though, recreational use does not appear to be a significant threat in Indiana. In addition, these plants occur on state property and cannot be collected without a permit (USFWS, 2007).

**Stressor:** Predation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Over-grazing by cattle on private property has the potential to adversely affect the species by eliminating flower production, but this effect has not been observed directly (USFWS, 2007).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Occurrences at Blue Licks Battlefield State Resort Park are protected from unauthorized taking; permits administered by the Kentucky Department of Parks and KSNPC are only issued for valid scientific purposes. Portions of occurrences 7a and 12a are protected through an MOU between KSNPC and KYTC (KSNPC 1989) that restricts habitat disturbance within these road rights-of-way. The Indiana occurrence occurs on state property (Harrison-Crawford State Forest) and is also protected from unauthorized taking. No such protection is available for occurrences located on private property in Kentucky or Indiana (USFWS, 2007).

**Stressor:** Other natural and manmade factors affecting its continued existence (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The species has been reduced to a small number of occurrences with a limited number of individuals. Consequently, the species is vulnerable to natural or human-induced factors (fire suppression) that might directly destroy individuals and further reduce population size (Federal Register 1985). Natural (secondary) succession can eliminate potential habitat for S. shortii through changes in vegetational composition. As old-field habitats and closed canopy woodlands develop, potential S. shortii habitat is lost (USFWS, 2007).

***Recovery***

**Reclassification Criteria:**

1. Adequate protection is obtained for the nine high priority occurrences and the habitat they occur in (USFWS, 1988).

2. Protected occurrences are determined to be self-sustaining and maintaining current population levels or above (USFWS, 1988).

3. Species biology and ecological requirements are sufficiently understood to determine and implement long-term management strategies (USFWS, 1988).

Recovery Priority Number: 8

**Delisting Criteria:**
1. Adequate protection is obtained for the nine high priority occurrences and the habitat they occur in (USFWS, 1988).

2. Protected occurrences are determined to be self-sustaining and maintaining current population levels or above (USFWS, 1988).

3. Species biology and ecological requirements are sufficiently u understood to determine and implement long-term management strategies (USFWS, 1988).

4. At least nine additional protected occurrences, equal in size and significance to the high priority occurrences mentioned above, are discovered in the vicinity of the Blue Licks population or at a currently unknown location (USFWS, 1988).

**Recovery Actions:**
- Protect existing occurrences and essential habitat. Prioritize occurrences for protection. Contact landowners and negotiate highest or most appropriate level of protection possible (USFWS, 1988).
- Conduct systematic searches for additional occurrences and populations. Identify potential habitat. Conduct ground searches (USFWS, 1988).
- Conduct studies of life history and ecological requirements. Delineate existing occurrences and establish permanent study plots. Analyze physical habitat and characterize habitat factors. Study phenology, pollination, and seed dispersal. Perform ex situ germination study and long-term demographic study. Determine management practices and develop recommendations to maintain health, vigor, and survivability of species (USFWS, 1988).
- Develop management plan and implement recommended management practices if determined beneficial. Conduct controlled burns, if determined beneficial. Remove overstory and/or aggressive competing vegetation if determined beneficial. Implement controlled rotational grazing system, if determined beneficial. Monitor results of management practices and re-evaluate needs as data on management results are obtained (USFWS, 1988).
- Maintain viable seeds. Collect and deposit seeds into seed banks. Make seeds available to organizations or institutions for propagation (USFWS, 1988).
- Continue management and monitoring of naturally occurring and reintroduced occurrences in Kentucky and Indiana, with consideration of intensified management at selected sites (USFWS 2017).
- Consider expansion of reintroduction efforts, with careful consideration of seed origin and genetics (USFWS 2017).

- Investigate and compare the genetic diversity/structure of Kentucky and Indiana populations, including the reintroduced occurrences in Harrison County, Kentucky (USFWS 2017).
- Investigate potential impacts of the bacterial leaf spot observed on occurrences in the Blue Licks area of Kentucky (USFWS 2017).
- Explore the potential threat posed by the horticultural cultivar S. shortii ‘Solar Cascade’ (USFWS 2017).
- Continue searches for new occurrences in the Blue Licks area, especially near known buffalo traces (USFWS, 2007).
- Conduct searches for new occurrences in riparian outcrop habitats of central Kentucky and southern Indiana or in upland areas of the region with suitable habitat (USFWS, 2007).
- Continue to investigate the life history and ecological requirements of the species (e.g., seedling establishment, seed and pollen dispersal distances) (USFWS, 2007).
- Continue to pursue permanent protection (through registry agreements, easements, or land purchases) of occurrences located on private property (USFWS, 2007).
- Expand the size of extant occurrences through habitat management and augmentation (USFWS, 2007).
- Establish viable occurrences in areas within the historical range that have suitable habitat, especially the Blue Licks Area of Fleming, Nicholas, and Robertson counties; develop criteria for establishing experimental populations in Kentucky (USFWS, 2007).
- Acquire potentially suitable but currently unoccupied habitat for the species where the species can be introduced and managed (USFWS, 2007).
- Continue implementation of management actions for permanently protected occurrences; develop a management strategy for the Indiana occurrence (USFWS, 2007).
- Revise the recovery plan (USFWS, 2007).

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities • Continue to pursue permanent protection (through registry agreements, easements, or land purchases) of occurrences under private ownership • Expand the size of extant occurrences through habitat management and augmentation • Establish viable occurrences in areas within the historical range that have suitable habitat, especially the Blue Licks area of Fleming, Nicholas, and Robertson counties, Kentucky, and the Falls of the Ohio area in Clark and Floyd counties, Indiana, and Jefferson County, Kentucky. • Develop criteria for establishing experimental populations in Kentucky • Acquire potentially suitable but currently unoccupied habitat for the species where the species can be introduced and managed • Continue implementation of management actions for permanently protected occurrences; work with Indiana DNR and the Indiana ES Field Office to develop a management strategy for the Indiana occurrence • Revise the recovery plan Monitoring and Research Activities • Continue searches for new occurrences in the Blue Licks area, especially near known buffalo traces • Conduct searches for new occurrences in riparian outcrop habitats of central Kentucky and southern Indiana or in upland areas of the region with suitable habitat • Continue to investigate the life history and ecological requirements of the species (e.g., seedling establishment, seed, and pollen dispersal distances) • Study the species’ population genetics (USFWS, 2023)

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# SPECIES ACCOUNT: *Spigelia gentianoides* (Gentian pinkroot)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 12/26/1990; Southeast Region (R4)

**Physical Description**

This small perennial herbaceous species possesses a single, erect, sharply ridged stem 10-30 centimeters (cm) (3.9-11.8 inches (in.)) long. The leaves are opposite, sessile, and in pairs at right angles to the next set of leaves. The leaves are largest at the top of the stem, 3-5 cm long, with lower leaves smaller. Flowers are borne in a short, few-flowered, terminal, determinate cyme. The flower consists of a narrow corolla tube of about 2.5-5 cm long, with five triangular lobes, each 5-6 mm long. The corolla is pale to dark pink; slightly darker at the margins of the lobes for the var. gentianoides. The stamens are within the flower, and the pollen grains are deposited along the bristles of the style (secondary pollen presentation). At anthesis , the corolla lobes of var. gentianoides are partially open, occasionally fully reflexed; whereas the corolla lobes of var. alabamensis are always fully reflexed. The green sepals are 4-6 cm long. The fruit is a capsule with two conspicuous round lobes. Peak flowering season occurs between May and June, however, plants have been seen flowering as early as April and as late as October. In a greenhouse, individual flowers last 2 to 5 days before wilting. Most seeds can be collected in June or July. (USFWS, 2012)

**Taxonomy**

At the time the Recovery Plan was issued, the species was comprised of two varieties located in Jackson and Calhoun counties (Florida), and Geneva and Bibb counties (Alabama). Morphological and molecular studies reassessed the appropriate ranks of these varieties and elevated variety  alabamensis to species (USFWS 2018, Weakley et al. 2011). Consequently, Spigelia gentianoides alabamensis is now a different species. (USFWS, 2019) Spigelia gentianoides  var. gentianoides was first collected in north Florida by Alvan Wentworth Chapman in 1837, probably from the west side of the Apalachicola River, in either Jackson or Calhoun counties. He identified the plant as S. floridana, later Alphonse de Candolle (1845) established the current epithet, S. gentianoides.  S. gentianoides alabamensis was first found in 1992 by James R. Allison (Georgia Natural Heritage Program, Georgia Department of Natural Resources) with Timothy Stevens, Jim Rodgers, and Debbie Rodgers while exploring the Little Cahaba River in Bibb County, Alabama. (USFWS, 2012)

**Historical Range**

Var. gentianoides:  Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama. Var. alabamensis:  Bibb County, Alabama. (USFWS, 2012)

**Current Range**

Spigelia gentianoides var. gentianoides is present in Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama. Spigelia gentianoides var. alabamensis is present in Bibb County, Alabama. (USFWS, 2019)

**Critical Habitat Designated**

No;

*Life History*

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Abiotic, Biotic, Self-pollination

**Breeding Season**

Adult: Peak flowering season occurs between May and June; However, plants have been seen flowering as early as April and as late as October. (USFWS, 2018)

**Other Reproductive Information**

Adult: Spigelia gentianoides can be propagated vegetatively and from seeds. Affolter (2005) successfully propagated S. alabamensis: by transplanting entire plants from the field to well drained potting mix; from stem cuttings, and by germinating seeds using cold stratification (2°C) or gibberellic acid (500-1000 ppm) treatments. Eight weeks of cold stratification provided excellent germination rates. (USFWS, 2018)

**Reproduction Narrative**

Adult: Secondary pollen presentation, a mechanism presenting the pollen on a structure other than the anther, appears to be present in S. gentianoides (Negrón-Ortiz, 2007, pers. observ.) and S. alabamensis; pollen was observed in the short bristles of the style. At the Geneva SF population, small Halictidae bees (sweat bees) were observed entering and exiting the flower of the S. gentianoides. (USFWS, 2018)

**Habitat Type**

Adult: Terrestrial (USFWS, 2012)

**Habitat Vegetation or Surface Water Classification**

Adult: well drained upland pinelands (var. gentianoides); glades (var. alabamensis) (USFWS, 2012)

**Dependencies on Specific Environmental Elements**

Adult: Fire-dependent ecosystems (USFWS, 2012)

**Spatial Arrangements of the Population**

Adult: Solitary individual or in small clumps (USFWS, 2012)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2012)

**Habitat Narrative**

Adult: Spigelia alabamensis is found in glades (open, almost treeless areas within woodland) that have developed over an ancient rock formation known as Ketona Dolomite. The Ketona formation contains a pure form of dolomite, crystalline in texture with only about 2% of siliceous impurities (Garland 2008). The glades vary in size from about 0.1 to 5 hectares with soil high in magnesium and calcium, low in phosphorus and potassium, and a pH ranging from 7.4 to 7.6 (Grossman et al. 1994). The topography varies from flat to sometimes very strongly sloping.

There are patches of exposed rock and thin-soiled areas dominated by grasses and other herbaceous vegetation. The plants in these glades are exposed to extreme heat and drought. At these sites, plants are quite abundant, and mainly found in small clumps adjacent to rocks. (USFWS, 2018)

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: The mechanism of seed dispersal is unknown, but the fruit does not appear to be adapted for long-distance dispersal (USFWS, 2009).

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2018)

**Number of Populations:**

7 (USFWS, 2023)

**Population Size:**

Var. gentianoides: ~3,900 individuals; var. alabamensis: unknown ("seems to be abundant") (USFWS, 2023)

**Additional Population-level Information:**

Very narrow distribution, low population density. (USFWS, 2018)

**Population Narrative:**

Spigelia gentianoides var. gentianoides is currently restricted to seven extant sites within four counties west of the Apalachicola River: Calhoun, Jackson, and Washington counties in Florida, and Geneva County in Alabama. These sites support about 3,900 plants. The species was originally recorded from nine sites but two sites are considered extirpated. Of the seven extant sites, two new were noted in 2013. Spigelia alabamensis (S. gentianoides var. alabamensis, sensu Gould 1996) is restricted to the Ketona Dolomite formation and glades of Bibb County, AL. This species seems to be abundant but the current number of individuals at these glades is unknown; therefore, population trends are also unknown for S. alabamensis. Some of the 17 glades where this species is found are owned and protected by TNC. (USFWS, 2018). Currently, it is restricted to seven extant locations within four counties west of the Apalachicola River: Calhoun, Jackson, and Washington counties in Florida, and Geneva County in Alabama (Fig. 1, Table 1). As of 2018, these sites supported about 3,900 plants. The species was originally recorded from nine locations, but two are considered extirpated (Fig. 1, Service 2012). Of the seven extant locations, two new were noted in 2013 (FNAI 2017). The extant locations are located on both public and private lands in fire-dependent longleaf pine-wiregrass and pine-oak-hickory ecosystems (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Habitat loss or modification (USFWS, 2018)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Conversion of much of the upland forest land in the four counties to pulpwood plantations (clearcutting, mechanical site preparation, and pine plantations) has possibly extirpated other populations. Clearcutting and/or selective thinning are of concern since typical silviculture operations often result in soil disturbance and compaction. In particular, site preparation practices resulting in soil disturbance, change in canopy cover from tree harvest, and change in fire frequency and seasonality are of concern. Land conversion coupled with disruption of pre-historical and historical fire regimes of the longleaf pine-wiregrass ecosystem is responsible for the rapid decline of the ecosystem where S. gentianoides is found. Several studies have shown that frequent prescribed fire regimes are important for maintenance of longleaf pine-wiregrass ecosystem (Hiers et al. 2007). Prescribed burnings at 3 – 5 year intervals seem to maintain optimal S. gentianoides populations. However, areas at Apalachee WMA are on a 2-year fire rotation where the largest population of S. gentianoides appears to be stable (A. Jenkins, FNAI, 8/15/2018, pers. comm.). However, it is unknown 1) if frequent fires is detrimental to recruitment, and 2) the implications of fire seasonality to S. gentianoides survival. Habitats converted to pine plantation, and managed without fire have created a shaded canopy. In addition, pine plantation management induces severe soil disturbance. According to Kral (1983), S. gentianoides would not survive the mechanical site preparation used in pine monoculture. This observation seems accurate due to the fragile nature of these plants, but the population located at the Spigelia Preserve seems to have survived, at least over the short term, after cutting and planting. Nevertheless, the population exhibited a decline immediately after the last timber harvest. Similarly, the population in Jackson Co. on land owned by Guy Anglin emerged in a former pine plantation. Urban development also threaten S. gentianoides. Conversion of much of forest land to residential development has possibly extirpated many populations. More than a third of Florida's land is projected to be developed by 2070 along with a growth of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Spigelia alabamensis is restricted to one county in northern Alabama. It is found in 17 glades, and TNC owns and protects about a dozen larger glades and some smaller glades. Populations on private property are threatened by future development for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes. (USFWS, 2018)

**Stressor:** Disease or Predation (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Neither diseases nor predation are currently known to be major threats to S. gentianoides or S. alabamensis. However, minor herbivore damage was noted at Three Rivers SRA and Geneva SF (B. Chowdhury, AU, 6/11/2018, pers. comm.) populations. (USFWS, 2018)

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Endangered Species Act (Act) of 1973, as amended prohibits the removal of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in

violation of state law or regulations or in the course of any violation of a state criminal trespass law. However, the Act does not provide protection for plants on non-federal lands unless it is in violation of state law. In Florida. S. gentianoides is listed as endangered under the Preservation of Native Plant Flora of Florida Act (PNPFF Act) (Rule: 5B-40.0055, Section 581.185-187, Florida Statutes; https://www.flrules.org/gateway/RuleNo.asp?ID=5B-40.0055). The PNPFF Act addresses the protection of endangered, threatened, or "commercially exploited" plants (http://www.sfrc.ufl.edu/Extension/florida_forestry_information/planning_and_assistance/threatened_and_endangered_species.html). The removal of protected plants from a property, whether for transplant, sale, or any other purpose, requires both the written permission of the landowner and a permit from the Florida Department of Agriculture and Consumer Services. In Alabama, the Alabama State Constitution provided the necessary authority to add plants to Alabama's section 6 cooperative agreement. Department of Conservation and Natural Resources has a policy to protect, conserve and increase the wildlife of the state [Ala. Code 9-2-2 (1)], but provides little direction as to how this is to be accomplished. While the state's Natural Heritage Program maintains lists of non-game species considered endangered, threatened, of special concern or poorly known, it does not apply penalties for taking listed species or for altering their habitats. The Nongame Wildlife Program, which was started in 1984, helps administer endangered and threatened species projects on federally and state-listed species, and also issues scientific collecting permits to enable a wide range of projects and collect the data for fishes, amphibians, reptiles, birds, and mammals (USFWS, 2018)

**Stressor:** Non-native plant interactions (USFWS, 2018)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, non-indigenous plants within or near extant populations of S. gentianoides do not pose a threat. However, Lygodium japonicum (Thunb. ex Murr.) Sw. (Japanese climbing fern) and Lonicera japonica Thunb. (Japanese honeysuckle) have been found in the vicinity of S. gentianoides, and both are becoming problematic in areas of the Southeast. (USFWS, 2018)

***Recovery***

**Reclassification Criteria:**
Downlisting of S. gentianoides from endangered to threatened status will be considered when (Criterion 5 was removed per USFWS 2019): (USFWS, 2012; USFWS, 2019)

1. Extant populations and newly discovered sites are identified and mapped (USFWS, 2012; USFWS, 2019).

2. Inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations; (USFWS, 2012)

3. Monitoring programs and management protocols on selected populations (e.g., largest populations) are established for 15 years to track threats to the species and its habitat (e.g., control exotic species, minimize site disturbance, urban development); (USFWS, 2012)

4. For var. alabamensis: the extant populations (including subpopulations at the Ketona Glades, Bibb Co., Alabama) located on public land are stable. (USFWS, 2012)

6. Research on key aspects related to demography (e.g., density, effect of fire on seedling establishment), reproductive biology, and seed ecology is accomplished (USFWS, 2012)

7. Viable germplasm representing > 50% of the populations for each variety is maintained in ex-situ. (USFWS, 2012)

Var. gentianoides: (1) sizes of populations in the Apalachee WMA, Three Rivers State Park, Calhoun Spigelia Preserve in Florida and the Geneva State Forest in Alabama are increased via prescribed burns until plant numbers are stabilized over a period of 15 years; (2) at least one new population is found, and; (3) at least one population is re-established within the historic range, specifically at sites where the plants are currently known to be extirpated. (USFWS, 2012)

Var. alabamensis: (1) 50 % the Bibb Co. glades known to support the variety on private land are protected through conservation agreements, easements, and/or land acquisition. (USFWS, 2012)

Recovery Priority Number: 2

**Delisting Criteria:**
The following Delisting Criteria are applicable to var. gentianoides: (USFWS, 2019)

1. Existing core populations [Apalachee WMA, TNC Spigelia Preserve, Three Rivers SRA, Rock Hill TNC Preserve, and Geneva SF] are restored and properly managed, and monitoring demonstrates that the populations are stable or increasing over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A, D, and E). (USFWS, 2019)

2. At least five (5) new populations are discovered or established within the historic range of the species on lands protected by a conservation mechanism. These populations should exhibit stable or increasing trends over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A and E). (USFWS, 2019)

3. Threats to S. gentianoides and its habitat (e.g., exotic species, site disturbance, urban development, hurricanes) have been managed and reduced to ensure the persistence of S. gentianoides into the foreseeable future (addresses Factors A, D, and E). (USFWS, 2019)

Delisting criteria for var. alabamensis have not been developed. (USFWS, 2012)

**Recovery Actions:**
- 1. Protect, manage, and secure existing populations and habitat. The distribution of Spigelia gentianoides is limited to a few areas in Northwest Florida extending into central Alabama (Fig. 2), thus it is important to secure and stabilize current and any newly discovered populations to prevent further decline of this plant. (USFWS, 2012).
- 2. Conduct surveys/inventories. Inventotory of current and new populations; field surveys and species distribution modeling to determine survey sites. (USFWS, 2012).

- 3. Establish new occurrences within the historic range of var. gentianoides, specifically in the sites where the plants are known to be extirpated (USFWS, 2012).
- 4. Maintain the species ex-situ in a protected facility. Ex-situ populations will serve as an important component for storage of germplasm and reintroducing S. gentianoides populations within the species range. (USFWS, 2012).
- 5. Conduct long-term monitoring and research; establish and implement a long-term monitoring program on selected sites, to include population biology/demographic studies and phenological studies. Conduct research into reproduction, pollination ecology, and breeding systems. Conduct reserach on seed bank, germination, and seedling survival. Conduct taxonomic and genetic studies. (USFWS, 2012)
- 6. Outreach: Develop and distribute information to the general public about S. gentianoides, how to protect and manage it for its recovery, and how lands can be managed to benefit the plant along with meeting landowner needs. Promote the implementation of the recovery actions via private landowners, academia, and public agencies. (USFWS, 2012)
- 7. Review and track recovery progress. (USFWS, 2012)
- Recommended Action from 2018 5-Year Review: Establish protection and management agreements with landowners. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct surveys/inventories on each known population. For each extant population, the following data should be collected once a year: the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring. (USFWS, 2018)
- Conduct a long-term study using populations distributed throughout the species' historical range Recommended Action from 2018 5-Year Review: for 10 years to document both distribution and abundance changes. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since gentian pinkroot occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Investigate if there is a soil seed bank persistence of S. gentianoides seeds throughout the species' geographic range. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct germination studies and investigate whether seedling recruitment is occurring. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Monitoring and managing for invasive species: Frequent inventories or surveys of the Florida populations for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the Three Rivers SRA population conducted by the Park staff. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct surveys/inventories on potentially new sites in Northern Florida and Alabama. This action can include the use of aerial photographs and species distribution n models to determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. (USFWS,

2018)

- Recommended Action from 2018 5-Year Review: Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct reproductive studies Since site disturbance occurs within the populations of S. gentianoides, it may pose problems to pollinator diversity (Kevan and Phillips 2001). Therefore, it is important to determine which insects are pollinators, and understand the value and pollinators' requirements so that actions can be taken to incorporate specific management or protection plans. Knowledge of the type of mating systems is essential for conservation of rare plant taxa because mating systems affect genetic diversity within and among populations (Navarro and Guitian 2002). Therefore, floral morphological analysis and experimental hand-pollinations are all recommended. (USFWS, 2018)
- Recommended Action from 2019 Amended Recovery Plan: Conduct research on key aspects related to (1) demography (e.g., density, effect of fire on seedling establishment), (2) reproductive biology, (3) levels and distribution of genetic diversity, (4) seed ecology to facilitate better understanding of this species' biology and potential impacts of threats such as low density, and changes in fire regime and (5) effects of catastrophic events such as hurricanes on populations and habitat of S. gentianoides (addresses Factor E, and resiliency, and inform representation). (USFWS, 2019)
- Recommended Action from 2019 Amended Recovery Plan: The effects of forest management practices (e.g., logging) on long-term persistence of S. gentianoides is assessed and a standardized monitoring technique is in place (addresses Factor D and resiliency). (USFWS, 2019)
- Recommended Action from 2019 Amended Recovery Plan: Inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations where appropriate habitat exists (addresses Factors A and D). (USFWS, 2019)
- Recommended Action from 2019 Amended Recovery Plan: A living collection of viable germplasm, collected from genetically distinct sites, is maintained in protected facilities (ex-situ) for research, recovery, and public outreach (addresses Factors A and E, and representation). (USFWS, 2019)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES 1. Establish protection and management agreements with landowners. 2. Conduct surveys/inventories on each known population. For each extant population, the following data should be collected once a year: the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring. 3. Conduct a long-term study using populations distributed throughout the species' historical range for 10 years to document both distribution and abundance changes. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since gentian pinkroot occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. 4. Investigate if there is a soil seed bank persistence of seeds throughout the species' geographic range. 5. Conduct germination studies and investigate whether seedling recruitment is occurring. 6. Monitoring and managing for invasive species, Frequent inventories or surveys of the Florida populations for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the Three Rivers SRA population conducted by the Park staff. 7. Conduct surveys/inventories on potentially new sites in Northern Florida and other suitable habitats. This action can include the use of aerial photographs and species distribution models to determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. 8. Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated. 9. Determine the long-term impacts of hurricanes and salvage logging on S. gentianoides populations. 10. Assess impacts of a reduced fire interval (2-year compared to longer 3- to 5-year interval) on populations of S. gentianoides including seed bank, seed germination, and recruitment. Specifically, to assess populations at Apalachee WMA and Geneva SF. (USFWS, 2023)

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# SPECIES ACCOUNT: *Spiraea virginiana* (Virginia spiraea)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 06/15/1990; Northeast Region (Region 5) (USFWS, 2015)

**Physical Description**

Colonial shrub up to 1.2 m high; largest stems 3-4 cm in diameter, dark gray, often arching or nearly horizontal; young stems upright, greenish-yellow to reddish-brown; branching often profuse in older specimens; leaves alternate, very variable in shape, size and degree of serration, generally mucronate-tipped, glaucous beneath, simply and singly serrate to entire, ranging from ovate to lanceolate; flowers 6 mm wide, bright to creamy white in tightly packed corymbs; corymbs variable in size, ranging from 5-22 cm, wide; follicles small, 2.0 mm long, 1.5 mm wide; seeds rarely produced. Fruit is a follicle. Flowering in June and July. Fruiting in August and September. (NatureServe, 2015)

**Taxonomy**

The two varieties sometimes recognized (var. serrulata and var. virginiana) are not maintained by Kartesz (1994 and 1999), nor are they recognized by any Heritage Program in the species' range, or by the U.S. Fish and Wildlife Service. Spiraea virginiana is distinguished from most other Spiraea by its creamy white flowers in corymbs, and its leaves which have an acute apex (Weakley 2004). (NatureServe, 2015)

**Historical Range**

Known historically in Pennsylvania. (NatureServe, 2015)

**Current Range**

Pennsylvania and Ohio south to Georgia and Tennessee. Records for Pennsylvania are historic. It occurs on streams that drain into the Ohio River and primarily within the Appalachian (Cumberland) Plateau and Blue Ridge physiographic regions, with at least one outlier in the Bluegrass Region of Kentucky. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Asexual (vegetative) and sexual (NatureServe, 2015)

**Breeding Season**

Adult: June to July (NatureServe, 2015)

**Key Resources Needed for Breeding**

Adult: The species’ flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long—horn beetles, a flower beetle, and a soldier beetle (R.L. Hoffman pers. comm.). (USFWS, 1992)

**Reproduction Narrative**

Adult: Although this element may flower profusely, it is clonal and almost exclusively reproduces vegetatively. Sexual reproduction will occur when genets are placed in close proximity but is rare in the native habitat (D.W. Ogle, pers. comm., 1996). Flowers bloom in June and July. The species' flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long—horn beetles, a flower beetle, and a soldier beetle (R.L. Hoffman pers. comm.). (USFWS, 1992)

**Habitat Type**

Adult: Riverine, Palustrine, and terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: High gradient, herbaceous wetland, riparian, scrub-scrub wetland, bare rock/talus/scree (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Found at elevations between 850 to 2,400 feet (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Colonies (USFWS, 1992)

**Environmental Specificity**

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

**Tolerance Ranges/Thresholds**

Adult: High (USFWS, 1992)

**Habitat Narrative**

Adult: Spiraea virginiana is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). Leopold et al. (1964) theorized that such areas are slow—changing, dependable aspects of the equilibrium in river systems. If this is true, the S. virginiana populations located there may be relatively stable; otherwise, they may be highly susceptible to extirpation. The habitat of this species is in oft-disturbed early successional areas, and its associates are determined by availability to recolonize after disturbance. A rangewide list of associates would run to several hundred, usually disturbance—adapted, species. A list of these species compiled from a sample of element occurrence records is found in Rawinski (1988) (USFWS, 1992).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds seem to be rarely produced. The seeds are very small (> 2 mm long x ca. 0.5 mm wide) and could be dispersed by wind or water. (USFWS, 1992)

***Population Information and Trends***

**Population Trends:**

Short-term trends indicate a decline of 10 to 30% (NatureServe, 2015)

**Adaptability:**

Moderate (USFWS, 1992)

**Population Narrative:**

The current range of Virginia spiraea is generally unchanged since the 1992 recovery plan, occurring in 7 states (Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, West Virginia) within the Ohio and Tennessee River basins; the species remains extirpated from Pennsylvania and Alabama. One EO with historic documentation has been rediscovered (Cheoah River, North Carolina) and 38 additional EOs (32 of them extant as of 2019) and 74+ sub-EOs have been discovered due to searches of rivers/streams with suitable habitat in known drainages, surveys of rivers/streams with known occurrences, and incidental finds when surveying for other species. However, 11 EOs became presumed extirpated (F or X rank) since 1992 when the species' recovery plan was completed. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Impoundments (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Impoundments are a double threat to the species: clones are not only destroyed by rising water, but the impoundment may also serve as a "death trap" for propagules washed down-stream. The probability of being washed into a suitable habitat may decrease from slim to none, thus breaking any possible continuity in downstream motility. (USFWS, 1992)

**Stressor:** Road-building and water release regulation (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A site on the Cheoah River in Graham County, North Carolina was probably destroyed by road-building and water release regulation (erosion control) below a dam. (USFWS, 1992)

**Stressor:** Industry development (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Areas along Hominy Creek in Buncombe County, North Carolina have been extensively developed by industries. (USFWS, 1992)

**Stressor:** Watershed management (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Cumulative and more subtle problems could occur from lack of watershed management and uncontrolled development of rivers. Bowles and Apfelbaum (1989) illustrate the effects of stochastic environmental events on another riverine species and graphically describe necessary conditions for survival. “Extinction possibility is increased by low disturbance, which favors plant succession and competition, or by high disturbance, which exceeds levels of ... population maintenance.” (USFWS, 1992)

**Stressor:** Reproduction and genetics (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** “Weak points” in the species’ biology may be a threat to its survival. Paucity of sexual reproduction dramatically decreases the intrinsic rate of reproduction and the dispersal potential of the plant’s small seeds. Genetic “fixation” of the clonal material may have adverse effects on the future breeding potential of the species, and the small number of genetically different individuals may constitute a threat. (USFWS, 1992)

**Stressor:** Insect predation (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Various insect pests have been seen on virginiana plants. Aphids of several types cluster at the rapidly growing shoot tips. Most of these are tended by ants, which move the aphids from place to place on the same plant, or from plant to plant. Aphids are most common on plants growing away from the water’s edge. On the beneficial side, lady bug beetles are regularly seen on these same stem tips. In another case, K. Walton (pers. comm.) identified a copper underwing moth caterpillar, a common and widespread species, that was doing damage in one population. However, for the most part, there is little evidence of anything other than local damage by insect pests. (USFWS, 1992)

**Stressor:** Introduced plants (USFWS, 1992)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Introduced alien plant species (e.g., Polygonatum cuspidatum, Liqustrum sinense, Spiraea japonica, and Rosa multiflora) are another, almost uncontrollable, detriment. (USFWS, 1992)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria are not available.

Recovery Priority Number: 8

**Delisting Criteria:**
1. Three stable populations are permanently protected in each drainage where populations are currently known. (USFWS, 1992)

2. Stable populations are established on protected sites in each drainage where documented vouchers have been collected. (USFWS, 1992)

3. Potential habitat in the states with present or past collections has been searched for additional populations. (USFWS, 1992)

4. Representatives of each genotype are cultivated in a permanent collection. (USFWS, 1992)

**Recovery Actions:**

- Protect existing populations and essential habitat through landowner cooperation and land acquisition. (USFWS, 1992)
- Search for additional populations. (USFWS, 1992)
- Conduct site-specific habitat manipulation as needed to maintain populations. (USFWS, 1992)
- Distinguish between N and n individuals and identify genetically different populations. (USFWS, 1992)
- Maintain cultivated sources for reproduction studies as well as conservation and reintroduction activities. (USFWS, 1992)
- Study the species' environmental tolerances and habitat characteristics. (USFWS, 1992)
- Re-establish populations within the historic range of the species. (USFWS, 1992)
- Inform land owners and managers about the plant's recovery needs. (USFWS, 1992)
- Monitor populations and evaluate effectiveness of recovery efforts. (USFWS, 1992)
- Protect existing populations and essential habitat. (USFWS, 1992)
- Conduct rangewide searches in areas of suitable habitat for additional populations. (USFWS, 1992)
- Conduct site-specific manipulation to maintain existing populations. (USFWS, 1992)
- Distinguish between N and n individuals. (USFWS, 1992)
- Maintain representative material from each known genotype in permanent cultivation. (USFWS, 1992)
- Investigate the species environmental tolerances and habitat characteristics. (USFWS, 1992)
- As appropriate, reintroduce S. virginiana in additional drainage systems within the species' historical range. (USFWS, 1992)
- Develop an information packet for landowners and land managers. (USFWS, 1992)
- Evaluate the effectiveness of protection and management programs and redirect efforts as necessary. (USFWS, 1992)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS Clarify recovery criteria 1 and 2 to support consistent evaluation and to reflect current information. Specifically, both recovery criteria should be clarified in terms of population assessment measures (e.g., what factors determine a "stable" population) and definition of "population." In addition, the definition of "drainage system" should be clarified as it relates to this species' recovery and definition of a population. Recommendations for specific recovery actions and priority number (1-3, based on priority number definitions in the Virginia spiraea recovery plan [Service 1992]): 1. Continue genetic analysis of Virginia spiraea across its range and within collections to determine genotypes and ploidy numbers, which will help guide potential propagation efforts and determine which localities/genotypes should be added to cultivated collections to provide genetic representation [Priority 1]. 2. Develop specific guidance on the treatment of invasive species that threaten this species and recommendations for habitat management to increase viability of the populations, in particular EOs with C or D ranks. Include invasive species specialists and encourage practical application of invasive species and habitat management in populations across the range [Priority 1]. 3. If deemed necessary based on the genetic analysis, develop a rangewide propagation and reintroduction plan [Priority 2]. 4. Coordinate with natural resource agencies to complete rangewide review and revision, if needed, of the Virginia spiraea species distribution model to help identify potential suitable habitat [Priority 2]. 5. Conduct comprehensive surveys of potential habitat in streams/rivers with known occurrences and no known occurrences, but identified in a species distribution model, to find new populations. Efforts should focus within the Blue Ridge and Appalachian Plateau physiographic provinces, where almost all EOs occur [Priority 2]. 6. Conduct surveys of extant EOs that have not been surveyed for more than 10 years to verify presence and update their EO ranks [Priority 2]. 7. Determine if there is suitable habitat in areas where the species has been historically documented or extirpated and search these areas. Some areas that should receive priority ranking for survey work include, but are not limited to: Cypress Creek, AL; Youghiogheny River, MD and PA; Little River, TN; Hominy Creek, NC; Monongahela River, WV; and New River, WV [Priority 3]. 8. Coordinate with natural resources agencies and Service Field Offices to develop methods and resolve nomenclature for accurately counting/measuring individual plants, population size, and populations to provide consistency and allow objective assessment of populations. Also coordinate to define appropriate ecological units (e.g., HUC units) to assist with organizing populations as it relates to species' recovery [Priority 3]. 9. Coordinate with natural resource agencies and NatureServe to utilize consistent definitions of EO and EO rank for Virginia spiraea across the range to allow analysis of population trends and consistent assessment of status [Priority 3]. 10. Develop educational materials for local government and public use aimed at increasing public awareness of the species, in particular in areas where development and recreational activities may impact Virginia spiraea [Priority 3]. (USFWS, 2021)

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# SPECIES ACCOUNT: *Streptanthus albidus ssp. albidus* (Metcalf Canyon jewelflower)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An annual herb, up to 1+ m tall. Basal leaves are narrow, coarsly toothed, the upper leaves not toothed and becoming linear. Flowers (April-July) are borne in leafless terminal clusters; they have have white to whitish-green sepals and white petals with purple-brown veins. The erect, flattened seed pods are 3-8 cm long. (NatureServe, 2015)

**Taxonomy**

Streptanthus albidus ssp. albidus (Metcalf Canyon jewelfiower) was first collected in 1887 by Volney Rattan, a botany teacher and author, from hillsides a few miles south of San Jose (Greene 1887). Edward Greene described Streptanthus albidus ssp. albidus in 1887 (Greene 1887); later he redefined the limits of Euclisia, formerly a subgenus of Streptanthus, treating it as a genus in its own right (Greene 1904). Streptanthus albidus ssp. albidus, as a member of the Euclisia group, was included in this change. Jepson (1925) returned Euclisia to subsection status, and later authors followed his treatment. Jepson (1925) also treated Streptanthus albidus ssp. albidus as a subspecies of Streptanthus glandulosus. Kruckeberg published a revision of the Streptanthus glandulosus complex in which he recognized the close relationships among Streptanthus glandulosus, Streptanthus albidus, and Streptanthus niger (Kruckeberg 1958). In this paper, he notes that the “sharp genetic discontinuity between Streptanthus albidus and all other populations, coupled with the morphological distinctness and regional restriction of Streptanthus albidus warrant the restoration of this Greeneian species.” He recognized two subspecies: Streptanthus albidus ssp. albidus and Streptanthus albidus ssp. Perarnoenus (Kruckeberg 1958). Recent research affirms the distinctiveness of Streptanthus albidus ssp. albidus. Streptanthus albidus ssp. peramoenus, and Streptanthus niger (M. Mayer. in litt., 1998) (USFWS, 1998).

**Current Range**

Santa Clara county, California. (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Streptanthus albidus ssp. albidus flowers April to June (Kruckeberg 1977) (USFWS, 1998).

**Reproduction Narrative**

Adult: Streptanthus albidus ssp. albidus flowers April to June (Kruckeberg 1977). No detailed data on its reproductive biology or demography are available. Nine populations totaling approximately 20,000 to 25,000 plants have been recorded (McCarten I992b) (USFWS, 1998).

**Habitat Type**

Adult: Outcrops

**Spatial Arrangements of the Population**

Adult: clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits serpentine outcrops with shallow soils (NatureServe, 2015). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on this species restricted habitat requirements and geography.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

9 (USFWS, 2023)

**Population Size:**

Highly variable (USFWS, 2023)

**Population Narrative:**

Known from 22 total occurrences, but only nine presumed extant (NatureServe, 2015). When we listed the subspecies in 1995, we estimated there were a total of 20,000 to 25,000 plants, based on estimates by McCarten (1992, pp. 4–6) for 8 of the 9 populations recognized at that time (Service 1995, p. 6676). The majority of those plants (15,000) were in Occurrence 4 (McCarten 1992, p. 6), which has since been determined to consist of most-beautiful jewelflower rather than Metcalf Canyon jewelflower (Vondracek 2021, p. 1). When we published our last status review in 2013, additional population estimates were only available for four unspecified occurrences (Service 2013, p. 14). Three of those estimates were published in 1989 and one in 2006. The four occurrences were highly variable in abundance, with counts of 27, 40, 1,000, and 5,000 plants (due to a typographical error, we reported the last count as

4,000 rather than 5,000 in our last review, but still indicated the total count as 6,067 (Service 2013, p. 14)). Three of the counts (27, 1,000, and 5,000) appear to be for Occurrences 2, 12, and 4, respectively (Diversity Database 2009, pp. 1, 3, 8). It is unclear which occurrence the fourth count (for 40 plants) refers to (Diversity Database 2009, entire). As discussed above, Occurrence 4 (with 5,000 of the 6,067 total plants) actually consists of most-beautiful jewelflower (Vondracek 2021, p. 1), and so would no longer count towards total abundance. Currently, Occurrence 2 is the largest occurrence, both by area and by number of plants. It consists of several subpopulations within 0.25 miles of each other, both within Metcalf Canyon and extending about a mile north and half a mile south of the canyon, encompassing about 200 acres in all (Diversity Database 2022). Total number of plants in the occurrence varied, with upwards of 14,000 in 2013, over 250,000 in 2014, upwards of 10,000 in 2015, and 5,000-plus in 2016 (Diversity Database 2023, p. 1). Occurrence 12 had 710 plants in 2013, about 1,675 the following year, upwards of 1,000 in 2015, and about 300 in 2016 (Diversity Database 2023, p. 4). Occurrence 17 had about 75 plants in 2013, 730 the following year, about 500 in 2015, and about 1,000 in 2016. Occurrences 15 and 18, on the Silver Creek Preserve, have survey counts starting prior to our last status review and continuing for several years after, although the counts for both occurrences were often combined. Table 1 shows the combined counts for Silver Creek Preserve. Although we lack total abundance estimates for Metcalf Canyon jewelflower across its range, there is nothing to indicate it has decreased since our last status review. Counts from year to year in the same locations have been highly variable, making it difficult to discern trends. Seedbanks likely contribute to the high variability from year to year by allowing plants to sprout in good years from seed left over the course of several years (Niederer and Whittall 2017, p. 60). The length of time that seeds remain viable in a seedbank is unknown and would provide an appropriate subject for research (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** t the time of listing, there were 13 documented sites, 9 of which still harbored plants. Two occurrences were known from herbarium records only. One of the historical records was visited in 1990, but no plants were found. Strepanthus albidus ssp. albidus was last observed at the other historical site in 1895. One population consisting of approximately 9,000 plants, approximately 45 percent of all known plants, occurred on the proposed site of the Cerro Plata residential and golf course project (also known as Ranch on Silver Creek Development). Although no direct destruction of any plants were planned at the time of listing, it was thought that construction activities, human disturbance, and habitat fragementation would result in significant impacts to the population. There was a proposed Valley Christian School and South Valley Christian Church that would destroy 61 percent of the 2,700 plants occurring on the site. The remaining 7 populations were also threatened by impending or potential development. The Ranch on Silver Creek Development (Cerro Plata) has been constructed since the time of listing. Although all direct impacts to Strepanthus albidus ssp. albidus were avoided as described in the biological opinion (Service 2000), the populations within the 580 acre parcel are intermixed with residential homes, golf course, and facilities. Ten years of monitoring (2001-2010) of the preserved populations within the on-site Hassler Ranch Preserve show that the Plant Conservation Areas are still occupied by Strepanthus albidus ssp. albidus. The total area occupied

within the Plant Conservation Areas has increased slightly by 3.65 acres. The numbers of plants have drastically reduced from 75,000 plants in 1998 to an average of 11,266 plants over 10 years (2001-2010). This is a reduction of 85% percent of the baseline prior to construction of the Silver Creek Development. One location at Tulare Hill was covered by fill during construction of a housing development (CNDDB 2012). Three sites within the Metcalf Energy Center Ecological Preserve are proposed for reintroduction (Whittall 2011). The reintroduction plan includes monitoring and preparation of a management plan (USFWS, 2013).

**Stressor:** Predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Herbivory was observed on approximately 8 individuals of Streptanthus albidus ssp. albidus at the Metcalf Motorcycle County Park. The herbivory was likely due to invertebrate herbivores since aphids and Pierid caterpillars have been observed in the populations there previously (Whittall, 2011) (USFWS, 2013).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** In summary, the Endangered Species Act is the primary Federal law that provides protection for these species since their listing as endangered in 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2013).

**Stressor:** Nitrogen deposition (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** A relatively recently identified threat is nitrogen deposition into grasslands from air pollution sources and the resultant increase in productivity of the soils has facilitated increased invasion of nonnative species (ICF 2012). The main effect for Santa Clara Valley dudleya and Metcalf Canyon jewelflower is their vulnerability to annual grass overgrowth. Nonnative annuals are much less dominant in serpentine areas, although increasing nitrogen deposition from air pollution has increased the productivity of serpentine soils and allowed a greater number of nonnatives to invade (Evens and San 2004; Harrison et al. 2003; Weiss 1999). Santa Clara Valley dudleya (Dudleya setchellii) lives on rock outcrops and is relatively immune from grass invasions except when extremely tall grasses smother small rock outcrops. The species persists on medium to large rock outcrops in ungrazed areas. Metcalf Canyon jewelflower can be a poor competitor against dense annual grasses, and some degree of grazing appears necessary to maintain populations (ICF 2012). Livestock grazing is an important management tool to combat increased invasive nonnative plants in serpentine grasslands due to atmospheric nitrogen deposition (Weiss 1999) (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** ICF (2012) summarized the potential effects of climate change to serpentine plant species and its relationship to the proposed permitted activities during the Santa Clara Valley Habitat Plan's proposed 50 year permit span. Serpentine plant distribution is restricted to highly specialized and localized habitat requirements that include species-specific microclimate conditions coincident with serpentine soil occurrence. Restriction to serpentine soils limits species range and distribution to this soil type. Climate change could change microclimate conditions so that species can no longer persist within their current range. Increase in favorable microclimate conditions could lead to an expansion of distribution and increase in abundance, both in terms of number of populations and number of plants within each population. Change in timing or intensity of seasonal events could have an effect on pollinator reproductive and plant flowering periods leading to phonological mismatches. The Santa Clara Habitat Plan (ICF 2012) includes a conservation strategy reserve design to reduce species vulnerability and provides opportunities for species and natural communities to adapt in response to climate changes (USFWS, 2013)

**Stressor:** Grazing (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although grazing is extremely useful for addressing threats from competition and nitrogen deposition, an incompatible grazing regime can also constitute a threat in its own right. A study of simulated grazing impacts on the closely related most-beautiful jewelflower found that jewelflowers can be clipped in half in early May with either no effect or a positive effect on growth and seed production, but that clipping close to the ground produces negative impacts (Weiss et al. 2007, pp. 7, 37). A comparison of grazed and ungrazed introductory plots on Tulare Hill (Occurrence 27) showed negative effects from grazing throughout the growing season, with the biggest impacts beginning in late April (Niederer and Whittall 2017, p. 34). This is the time when jewelflower plants start producing flowers and seeds and thereby become more attractive to cattle. As summer progresses jewelflowers are targeted even more by cattle, because they remain green and stand out against the drying grass (Niederer and Whittall 2017, p. 50). The reproductive stage of the Metcalf Canyon jewelflower lasts through November (Niederer and Whittall 2017, p. 34), so the largest threat from grazing is likely to occur from late April through November (USFWS, 2023).

**Stressor:** Climate change (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In our last status review we noted that climate change could have either positive or negative effects, depending on how it affects microclimate conditions in occupied serpentine areas (Service 2013, pp. 26–27). Microclimate conditions refer to the set of atmospheric conditions typical for a small area. We note here that climate change could also produce indirect impacts by increasing variation in weather conditions, thereby elevating the likelihood of atypical conditions such as droughts or unusually heavy precipitation (Ault 2014, pp. 7529, 7545; Williams et al. 2015, p. 6819; Berg and Hall 2015, pp. 6324, 6332). Either of these effects could lead to

negative impacts on Metcalf Canyon jewelflower, depending on grazing and topography at a given occurrence. High-precipitation years would tend to encourage growth of annual grasses, which would then compete with Metcalf Canyon jewelflower unless held in check by grazing or other methods (WRA 2019, p. 23). High precipitation could also cause landslides which could bury or undermine Metcalf Canyon jewelflower growing on steep slopes, particularly at roadcut occurrences such as 12, 26, and portions of Occurrence 2. Droughts would tend to restrict growth of competing nonnative grasses but could result in increased grazing damage if adequate forage elsewhere was unavailable during summer months. More serious droughts could also directly impact the ability of Metcalf Canyon jewelflowers to grow and reproduce, and any such droughts that lasted several years might tend to deplete the jewelflower seedbank at a given location (USFWS, 2023).

**Stressor:** Hybridization with most-beautiful jewelflower (USFWS, 2023)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The southeastern end of the Metcalf Canyon jewelflower range meets and somewhat overlaps the northwestern end of the most-beautiful jewelflower range in an area southeast of Metcalf Canyon (Whittall et al. 2023, p. 50). Because the two jewelflowers can interbreed (ICF 2012, p. 7-69; Valley Habitat Agency 2020b, p. 34), there is a potential, that we have not previously considered, for one or more southern Metcalf Canyon jewelflower occurrences to be lost due to takeover of the areas by hybrids. It is also likely that the proposed Metcalf Canyon jewelflower occurrences in the CROSP are hybridized to some extent, which must be considered when deciding whether they constitute Metcalf Canyon jewelflower occurrences (see below). Hybridization could be occurring in three ways: (1) due to short flights of pollinating insects between plants of different subspecies that essentially occupy the same occurrence in areas of range overlap; (2) due to long-distance flights of pollinating insects between separate occurrences of each subspecies; and (3) by transport of seeds from occurrences of one subspecies to another via the coats or manure of cattle. This would be followed by cross pollination between the resulting plants growing in the occurrence (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Secure and protect specified recovery areas. Occupied habitat along with adjacent unoccupied habitat and a 150-meter (500- foot) buffer at nine known sites. Management plan approved and implemented for recovery areas, including survival of the species as an objective. For all populations and any occupied or unoccupied habitat identified as essential to survival.

Recovery Priority Number: 3C

**Delisting Criteria:**
Secure and protect specified recovery areas. 18 populations representing entire historic range of the species.  from incompatible uses:

**Recovery Actions:**

- Population monitoring in specified recovery areas shows: Downlist: Stable or increasing for a period of 20 years that include the normal precipitation cycle (or longer if suggested by the

results of demographic monitoring). Delist: No decline after downlisting; if declining, determine cause and reverse trend.
- Preserve, protect, manage, and monitor Dudleya setchellii CNDDB occurrence number 43. Occurrence number 43 was found in the year 2005, subsequent to listing of the species and the Recovery Plan. The occurrence represents the most southwesterly extent of its current known range (USFWS, 2013).
- Confirm if the historic and current westernmost and southernmost occurrences for Streptanthus albidus ssp. albidus are valid. Perform additional surveys in suitable habitat around CNDDB number 6 and 21 to confirm if the range of the species is smaller than previously understood (USFWS, 2013).
- Conservation measures should include focus on preserving, monitoring, and managing pollinator fauna as it appears to be essential for any significant fruit set in Streptanthus albidus ssp. Albidus (USFWS, 2013).
- Streptanthus albidus ssp. albidus plant numbers can fluctuate drastically from year to year (Whittall 2011). Reliable methods should be developed to evaluate when a population should be considered as stable and viable. The methods should include ways to measure and evaluate natural and human influenced variables

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Metcalf Canyon jewelflower. 1. Research should be conducted into the length of time that Metcalf Canyon jewelflower seeds can remain viable in the soil. This would support estimates regarding the ability of a population to rebound from multiple years of poor conditions, and to maintain genetic diversity. 2. Work with the landowner of the Silver Creek Preserve (Occurrences 15 and 18) to establish and fund an endowment for long-term management of the habitat and ongoing monitoring of the jewelflower population. 3. Grazing should be considered as a management tool at all known occurrences to control invasive grasses. If grazing is not feasible, the extent of competition with non-native grasses in the area should be monitored so that the importance of, and options for, weed abatement can be considered. 5. Monitoring of both direct grazing impacts to jewelflower plants, and of residual dry matter (RDM) should be implemented at Occurrence 27 at Tulare Hill, as described in the 2021 annual monitoring report for the site (Weiss et al. 2021, pp. 26, 93). This will provide better information on how much grazing the site can support, and over what time periods, before it changes from beneficial to detrimental for the jewelflower. 6. Efforts should continue to develop tests (including genetic tests) allowing consistent and accurate differentiation of Metcalf Canyon jewelflowers, most-beautiful jewelflowers, and hybrids of the two. This will allow biologists to investigate the extent to which hybrids may be spreading through Metcalf Canyon jewelflower occurrences, particularly in the southern portion of the range. It will also allow biologists to confirm the Metcalf jewelflower occurrences tentatively identified in the CROSP. 7. Research should be conducted into the ease of transport and subsequent germination of Metcalf Canyon jewelflower and most-beautiful jewelflower seeds on the coats, or in the digestive tracts, of cattle. 8. Now that the reintroduction effort to establish Occurrence 27 at Tulare Hill appears successful, additional new populations should be created using the knowledge gained. For instance, seeding densities for such new populations should be high, and seeding efforts should be conducted over multiple years (Weiss et al 2021, p. 93). Provisions should also be taken to limit grazing impacts to the extent possible, such as by seeding in areas less accessible to cattle, or by establishing a grazing plan that applies adaptive management techniques to monitor post-April grazing impacts and adjust grazing limits accordingly. 9. The discovery of up to eight possible new populations in the CROSP (Niederer et al. 2017, p. 19) suggests there may be additional undiscovered natural populations within the subspecies' range. Additional surveys should be conducted to either establish or provisionally rule out their presence in currently unsurveyed areas, as well as to monitor the occurrences in the CROSP. Population numbers can occasionally drop to zero and then rebound from seeds, so a single negative survey would only rule out an area provisionally. 10. A final survey of the area in the general vicinity of Occurrence 19 at Communications Hill should be conducted, preferably early in the growing season, over at least two years spanning a wide range of precipitation levels, to rule out the possibility of any jewelflower plants persisting at or near the location. 11. The Recovery Priority Number for this subspecies is currently 3C. The "C" indicates a potential conflict with development or with other forms of economic activity (48 FR 4304). Although the Valley HCP removes development as a likely source of conflict, there may be other forms of economic activity such as grazing that remain in potential conflict at some occurrences. At this point, the potential for such conflicts remains unclear. We recommend reconsidering this issue in our next status review (USFWS, 2023).

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# SPECIES ACCOUNT: *Streptanthus bracteatus* (Bracted twistflower)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened

**Physical Description**

Bracted twistflower (Streptanthus bracteatus) is a herbaceous annual plant of the Mustard Family (Brassicaceae) currently reported from five counties of south-central Texas. The seeds germinate in response to fall and winter rainfall, forming basal rosettes (clusters of leaves that radiate from the root crown); the young plants resemble radish seedlings. The waxy bluish-green basal leaves, up to 15 centimeters (cm) (5.9 inches (in)) long, have broadly lobed margins. Flower stalks emerge the following spring bearing showy lavender-purple flowers; often these stalks are un-branched and 46 to 61 cm (18 to 24 in) tall, but may reach 137 cm (54 in) in height, and have several long branches. The lower stem leaves have an elongated heart shape and the upper leaves are progressively shorter, ultimately reduced to very short, triangular bracts (modified leaves) at the base of each flower stem. Thin seed pods, known as siliques, are up to 12 cm (4.7 in) long and 4 millimeters (mm) (0.15 in) wide; they mature and dry during the summer, finally splitting open to release flattened seeds with narrow wings. The foliage withers as the fruits mature, and the plants die during the blazing heat of summer.

**Taxonomy**

Family: Brassicaceae (mustards). About 100 species of Streptanthus have been described, although many of these have more recently been placed in Caulanthus, Boechera, Thelypodium, or other genera (Tropicos 2011a, pp. 12). Gray (1848, p. 146) described Streptanthus bracteatus as a new species, based on specimens collected by Ferdinand Lindheimer near New Braunfels, Texas, in 1846. Kuntze (1891, p. 933, cited in Tropicos 2011c, p. 1) classified this taxon as Erysimum bracteatum (A. Gray) Kuntz. Nevertheless, the Flora of North America (Al-Shehbaz 2011, p. 706), Tropicos (2011b, p. 1), the Integrated Taxonomic Information Service (2011, p. 1), the International Plant Names Index (2011, p. 1), and the Plants Database (Natural Resources Conservation Service 2011, p. 1) treat this taxon as a valid species with the name Streptanthus bracteatus. Pepper (2010, p. 14) concluded that S. bracteatus is a morphologically and evolutionarily distinct species; its closest extant relative is the broadpod jewelflower, S. platycarpus, a west Texas endemic. Poole et al. (2007, p. 470) list bracted twistflower and bracted jewelflower as common names for this species. While the latter is also used by the Plants Database, the botanists and conservation organizations who work with this species primarily use the former name. For the purposes of this document, we will refer to Streptanthus bracteatus as bracted twistflower.

**Historical Range**

U.S., Texas. Historic collection records where the species has not been observed since 1989: Comal, Bandera/Kerr, Real, Bexar counties.

**Current Range**

U.S., Texas. Bexar, Hays, Medina, Travis, and Uvalde counties. Endemic to a small area of the Edwards Plateau of Texas.

**Critical Habitat Designated**

Yes; 5/11/2023.

**Legal Description**
We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the bracted twistflower (Streptanthus bracteatus), a plant species from Texas. In addition, we designate critical habitat for the bracted twistflower. In total, approximately 1,596 acres (646 hectares) in Uvalde, Medina, Bexar, and Travis Counties, Texas, fall within the boundaries of the critical habitat designation. This rule applies the protections of the Act to this species and its designated critical habitat.

**Critical Habitat Designation**
Critical habitat units are depicted for Bexar, Medina, Travis, and Uvalde Counties, Texas.

**Primary Constituent Elements/Physical or Biological Features**
The physical or biological features essential to the conservation of bracted twistflower consist of the following components:

(i) Karstic, dolomitic limestones underlain by less permeable limestone strata, where perched aquifers seep to the surface along slopes. These are often found within 2 kilometers of the exposed boundary of the Edwards or Devils River and Glen Rose geological formations

(ii) Native, old-growth juniper-oak woodlands and shrublands along the Balcones Escarpment

(iii) Herbivory from white-tailed deer and introduced ungulates of such low intensity that it does not severely deplete populations prior to seed dispersal

(iv) Tree and shrub canopy gaps that allow direct sunlight to reach the herbaceous plant layer at least 6 hours per day

(v) Viable populations of native bee species and the abundant, diverse forb and shrub understory that support them

**Special Management Considerations or Protections**
When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protections to reduce the following threats: Habitat loss due to urban and residential development, increased woody plant cover, severe herbivory by native and introduced ungulates, and trampling and erosion from recreational use. Management activities that could ameliorate these threats include (but are not limited to) juniper thinning, prescribed fire, fencing to exclude deer and other herbivores, herd management of local ungulate populations, and protection from foot and bicycle traffic. These management activities will protect the physical and biological features essential for the conservation of the species by reducing herbivory, maintaining open canopies, protecting the habitat from trampling and erosion, and conserving diverse shrub and forb understory vegetation that supports the species' native bee pollinators.

***Life History***

**Food/Nutrient Resources**

**Lifespan**

Adult: 1 year (annual) (USFWS, 2021)

**Breeding Season**

Adult: Bloom April and may continue to May and early June

**Reproduction Narrative**

Adult: Bracted twistflower has an annual lifespan, meaning that it completes its entire life span within one year. It may also be considered a winter annual or biennial, since the seeds germinate in the fall of one calendar year, and the emerging plants reach maturity, produce seeds, and die during the summer of the following year. Zippin (1997, p. 222) determined that from 79 to 90 percent of seed germination occurs during the months of October and November. The plants form a rosette of radially-arranged basal leaves (Figure 1.1) that develop during the fall and winter; during this time, the plants store nutrients and water in a tap root. Positive identification is somewhat difficult during the rosette stage, since bracted twistflower resembles other members of the Mustard family, including rock cress (Arabis petiolaris) (Damude and Poole 1990, p. 6). (USFWS, 2021)

**Habitat Type**

Adult: Primarily in oak-juniper woodlands and associated openings on slopes and in canyon bottoms with shallow, well drained, gravelly clays and clay loams over limestone. Often found amid dense shrub growth where some protection from browsing animals is afforded, but is not ideal habitat.

**Habitat Vegetation or Surface Water Classification**

Adult: Forest/Woodland; Shrubland/Chaparral, Woodland - Mixed

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2014)

**Habitat Narrative**

Adult: Bracted twistflowers are best adapted to sites with less than 50 percent cover of woody plants, and that severe herbivory by dense populations of white-tailed deer has largely extirpated the plant from its optimal habitats. It may persist for a time in the protection of dense thickets, or it may gradually decline. In addition, the germination of seeds and reproduction of bracted twistflower in the wild appears to respond to as-yet unknown triggers. This compels us to consider how historic vegetation changes may have affected bracted twistflower populations. Bray (1904, pp. 14, 22) described a very apparent, ongoing transition of Edwards Plateau uplands from grassland to woodland at the beginning of the twentieth century. At that time, the well-watered canyons supported dense forests with trees over 500 years old; stunted but continuous forest covered hills and bluffs; sparse trees were found on loose, stony slopes in the eastern Edwards Plateau (precisely where bracted twistflower populations currently occur); and trees were then invading the open prairies on the level plateau divides (uplands), which previously were free of woody vegetation (Bray 1904, pp. 1415). He attributed this change to overgrazing and the consequent depletion of grasses, erosion, and cessation of wildfires, and stated that open prairies had been converted to dense oak scrub in a span of 25 years (Bray 1904, pp. 1415, 2223). These historic descriptions support a hypothesis that bracted twistflower is a relict of a woodland-grassland ecotone (transition zone) that occurred at or near the confluence of loose, stony slopes and prairie uplands. This savanna, in the broad sense of the term, would have been influenced periodically by wildfires of varying intensity and frequency. Some Streptanthus species, such as S. heterophyllus (San Diego wild cabbage), germinate following wildfires (Moreno and Oechel 1991, pp. 19992000), thus, fire may also be a trigger of bracted twistflower emergence.

***Dispersal/Migration***

**Dispersal**

Adult: Seeds disperse by gravity (Fowler et al. 2012, p. 1512), although other mechanisms, such as water flowing over the soil, may also occur. The foliage withers as the fruits mature, and the plants die during the blazing heat of summer (USFWS, 2023).

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2023).

**Number of Populations:**

13 EOs (=populations); 9 with intact habitat, 4 with degraded or partially destroyed habitat (USFWS, 2014). 14 extant populations (USFWS, 2023).

**Population Size:**

~6,200 individuals (USFWS, 2014)

**Population Narrative:**

Of the 16 EOs (Element Occurrences=geographic sites) observed since 1989, 9 EOs remain with intact habitat, 2 EOs are partially intact, 2 are on managed rights-of-way, and 3 sites have been developed and the populations are presumed extirpated. Only 7 of the intact EOs and portions of 2 EOs, representing 2,502 individuals (33 percent of the maximum populations observed since 1989), are on protected natural areas. Four EOs with 3,708 individuals (48 percent of the maximum populations) are intact but vulnerable to development and other impacts. Five EOs have been partially or completely developed, resulting in the loss of 1,449 individuals (19 percent of the maximum populations). Two EOs were destroyed in 2012 and 2013 (USFWS, 2014). The maximum populations observed at these EOs range from a few up to about 2,000 individuals; in 2012, a pulse year for many populations, 1,463 individuals were observed at 14 extant EOs. Since 1989, two EOs have been eradicated and four others have been mostly destroyed by residential development. We estimate that 33 percent of the potential population has been lost due to habitat development during this time. Populations on many of the remaining habitats have also declined. We recognized bracted twistflower as a candidate for listing under the Endangered Species Act (ESA) on October 26, 2011 (76 FR 66370). Additionally, on July 31, 2014, we received a petition to list the species (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Urban development
**Exposure:** Degradation and destruction of habitat
**Response:**
**Consequence:**
**Narrative:** The greatest threat to bracted twistflower is habitat loss due to urban and residential land development (McNeal 1989, p. 17; Damude and Poole 1990, p. 51; Zippin 1997, p. 229; Fowler 2010, p. 2; Pepper 2010, p. 5). Our analysis of the 16 EOs reported since 1989 indicates that 3 have been extirpated, portions of 2 have been extirpated, 2 are in disturbed habitat, and 9 are intact. Of the intact EOs, 2 are vulnerable to development, and 7 intact EOs and portions of 2 EOs, representing 33 percent of the maximum populations recorded since 1989, occur in protected natural areas. The Rough Hollow population in Hays County was discovered in 2010; by 2012, the site had been bulldozed. The Cat Mountain population in Travis County, which was a core reservoir of the species genetic diversity (Pepper 2010, p. 12), was located on private land that was sold in 2011 (Bracted Twistflower Working Group 2010, pp. 34; Stewart 2012); this site was completely bulldozed in 2013 (Fowler 2014, p. 16). Habitat loss is an imminent threat throughout the species range to the populations not on protected natural areas and is likely to continue.

**Stressor:** White-tailed deer, small mammals, exotic ungulates
**Exposure:** Browsing
**Response:**
**Consequence:**
**Narrative:** Severe herbivory by white-tailed deer is a major, imminent threat to bracted twistflower throughout the species' range, except where populations are protected from deer by fencing or intensive herd management (hunting) (McNeal 1989, p. 17; Damude and Poole 1990, pp. 5253; Dieringer 1991, p. 341; Zippin 1997, pp. 39197, 227; Leonard 2010a, pp. 3643; Fowler 2014, pp. 17, 19) and is exacerbated by the extremely high deer densities in the Edwards Plateau of Texas (Zippin 1997, p. 227). The foliage of bracted twistflower is very palatable to many browsing animals, including squirrels (Fowler 2010, p. 7), and even humans (Kral 1990 cited in Damude and Poole 1990, p. 51). Exotic ungulate species such as aoudad (Ammotragus lervia), which have been widely introduced on game ranches and now exist in self-sustaining feral populations in central Texas, present an additional potential threat (Damude and Poole 1990, pp. 52 - 53). It is also likely that bracted twistflower populations were impacted during historic periods of poor rangeland management in central Texas, particularly by herds of goats and sheep.

**Stressor:** Woody plant density
**Exposure:** Decreased habitat
**Response:**
**Consequence:**
**Narrative:** Changes in vegetation structure and composition, specifically the increased density of woody plant cover, appear to be detrimental to bracted twistflower (Pepper 2010, p. 5). The species benefits from higher light intensity and duration than it receives in many of the extant populations; its persistence in dense thickets may be due to increased herbivory of the plants growing in more open vegetation (Leonard 2010a, p. 63; Ramsey 2010, p. 22). The positive reproductive response of bracted twistflower to higher light levels is consistent with the hypothesis that it may also be a fire-adapted species (Fowler 2010, pp. 3, 10). Bray (1904, pp.

1415, 2324) documented the rapid transition of grasslands to woodlands in the Edwards Plateau occurring more than a century ago; he attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. We conclude that bracted twistflower habitats were probably influenced by frequent wildfires and that the frequency of wildfires has decreased greatly since pre-settlement times; therefore, bracted twistflower may be a fire-adapted species, and the lack of wildfire may have contributed to its decline. The increase in density of woody plant cover has occurred incrementally over a span of decades, but affects most bracted twistflower populations, including those on protected natural areas, and may also have caused a gradual decline in population sizes. In addition, optimal vegetation management of bracted twistflower populations may be incompatible with the management of nesting habitat of the endangered golden-cheeked warbler.

**Stressor:** Powdery mildew fungus
**Exposure:** Disease infestation
**Response:**
**Consequence:**
**Narrative:** Bracted twistflower is highly susceptible to attack from a powdery mildew fungus (Ascomycota, family Erysiphaceae) which may be more severe when plants grow in dense, shaded thickets (Ramsey 2010, p. 21; Leonard 2010a, p. 53). The species of fungus has not yet been identified; it may be an introduced pathogen to which bracted twistflower has no resistance (Bracted Twistflower Working Group 2010, p. 2). We do not yet know the magnitude of this threat. However, Fowler (2014, p. 17) found that, contrary to expectation, the incidence of powdery mildew was positively associated with reproductive output (plants with greater degrees of powdery mildew infestation produced more viable seed).

**Stressor:** Recreation
**Exposure:** Erosion and trampling
**Response:**
**Consequence:**
**Narrative:**

**Stressor:** Land use changes (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A major threat to bracted twistflower is habitat loss due to urban and residential land development (McNeal 1989, p. 17; Damude and Poole 1990, p. 51; Zippin 1997, p. 229; Fowler 2010, p. 2; Pepper 2010, p. 5). As described in Section 2.4, 82 percent of bracted twistflower EOs are within 2 km (1.2 mi) of the Edwards/Devils River and Glen Rose geological formations. This narrow crescent along the eastern and southern edges of the Edwards Plateau follows the Balcones Escarpment. Along this escarpment are many springs that provide good quality water from the Edwards Aquifer. Since potable surface water is scarce in many parts of Texas, colonists built towns along the escarpment during the 18th and 19th centuries. These towns have now grown into cities, including Georgetown, Austin, San Marcos, New Braunfels, and San Antonio; collectively known as the Interstate 35 corridor, this is one of the fastest-growing urban complexes in the U.S. Consequently, urban development has consumed all or most of the habitat at six EOs. Figure 10 shows the known populations of bracted twistflower overlaid on projected urban growth along this corridor by 2050 (Hill Country Alliance 2018)—a visual demonstration

that additional populations and habitats are threatened by urban development and other land use changes. (USFWS, 2021)

**Stressor:** Changes in the structure and composition of vegetation and in wildfire frequency (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Laboratory and field experiments conducted by Fowler (2010, pp. 10–11), Leonard (2010a, p. 63), and Ramsey (2010, p. 20) demonstrated that growth and reproduction of bracted twistflower benefits from higher light intensity and duration than it receives in many of the extant populations; its persistence in dense thickets may be due to increased herbivory of the plants growing in more open vegetation (Leonard 2010a, p. 63; Ramsey 2010, p. 22). Some Streptanthus species, such as S. heterophyllus, germinate in response to wildfire (Moreno and Oechel 1991, pp. 1999 to 2000). One trial showed that bracted twistflower seed germination is enhanced by exposure to karrikins, substances produced by burned vegetation that stimulate germination of many fire-following plants (Flematti et al. 2004; Stewart 2012c, d, e). The positive reproductive response of bracted twistflower to higher light levels and its germination response to karrikins are consistent with the hypothesis that it may also be a fire-adapted species (Fowler 2010, pp. 3, 10; see discussion in Sections 2.3, 2.4, and 3.2). Bray (1904, pp. 14–15, 23–24) and Fonteyn et al. (1988, p. 79) documented the rapid transition of grasslands and savannas in the Edwards Plateau to dense juniper thickets beginning around 1850; they attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. An alternate viewpoint concluded that pre-settlement juniper forests were extensive, and that fire frequency has not decreased in the last 150 years, in the Balcones Escarpment region of the Edwards Plateau (O'Donnell 2019, pp. 35–36). Nevertheless, we conclude that the preponderance of evidence supports the hypothesis that bracted twistflower habitats were periodically renewed by frequent wildfires in pre-settlement times and that the frequency of wildfires has subsequently decreased; bracted twistflower is likely to be a fire-adapted species adapted to woodland edges and openings, and the lack of wildfire may have contributed to the deterioration of its habitat and to the decline of its populations. Woody plant cover has increased in density incrementally over a span of decades andaffects most bracted twistflower populations, including those on protected natural areas. (USFWS, 2021)

***Recovery***

**Recovery Actions:**

- Search for new populations on public conservation land as well as private lands (with landowner permission).
- Provide technical guidance and material support to private landowners who voluntarily wish to conserve the species on their land.
- Manage the existing populations on protected natural areas more rigorously, including installation of deer exclosures, closing illicit foot and mountain bike trails, enforcing applicable regulations that protect the habitats on public property, and conducting public outreach.
- Maintain less than 50 percent cover of woody plants at occupied habitats to the extent allowed under the existing habitat management plans or applicable regulations.

- Protect multiple populations within each area of the species genetic diversity in Medina and Travis counties.
- Investigate the species ecology and optimal habitat requirements, particularly the fire ecology, geology, and associated vegetation structure.
- Conduct pilot reintroductions to determine effective methods of population reintroduction and augmentation. Reintroduction and augmentation must use seeds from ecotypes adapted to the sites. Avoid translocating propagules of an ecotype into sites that support a genetically distinct ecotype.
- Collect seeds from extant populations for seed bank storage and propagation. Propagate plants from the representative genetic ecotypes (genotypes that are specifically adapted to a specific ecological area) and produce seed for experimental and reintroduction efforts (to prevent excessive collection from wild sources and depletion of the soil seed bank at extant populations).

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# SPECIES ACCOUNT: *Suaeda californica* (California seablite)

***Species Taxonomic and Listing Information***

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

**Physical Description**

An evergreen shrub that forms low mounds, leafy with fleshy, narrow leaves, each 5-35 mm long. The tiny flowers (2-3 mm across) are borne July-October. (NatureServe, 2015)

**Taxonomy**

Suaeda californica was first described by Sereno Watson in 1874, based on type material collected by Bolander and Kellogg in San Francisco Bay tidal marshes. Amos Heller published the name Dondia californica in 1898, recognizing the genus name used by Michel Adanson in 1763. However, the name Suaeda has been conserved (Abrams 1944). Munz (1959) recognized several previously recognized taxa as subspecies of S. californica, and described the range as extending from San Francisco Bay south to Lower (Baja) California. Ferren and Whitmore (1983) noted that much of what had been identified as S. californica in southern California was a distinct taxon, which they named S. esteroa. Further study revealed that the only extant populations of Suaeda that resemble the type specimen of S. californica are those that occur in the vicinity of Morro Bay. In his revision of the genus, Ferren (1993) recognized S. californica as a full species (USFWS, 2013).

**Historical Range**

See Current

**Current Range**

Extirpated from the San Francisco Bay area; now known only from Morro Bay, San Luis Obispo County. May have once occured in Sonoma County as well (Skinner and Pavlik 1994). Does NOT occur in southern California or Baja California - plants of these areas are referable to S. esteroa &/or S. taxifolia (Skinner and Pavlik 1994, USFES 1994). (NatureServe, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Wind pollinated? (USFWS, 2013)

**Breeding Season**

Adult: Flowers typically appear from May to October, but mostly in late summer. Occasional flowers may be found at other times of the year, sometimes emerging as early as late spring (McMinn 1939, Baye pers. observ.) (USFWS, 2013).

**Reproduction Narrative**

Adult: Suaeda californica produces seeds throughout its lifespan. Reproduction appears to be entirely by seed (sexual); there are no known reports of natural regeneration from vegetative fragments. The spread of individual plants can be extensive, and sometimes resembles clonal populations. However, they have not been observed to spread clonally. Vegetative stem cuttings of S. californica treated with synthetic auxins (hormones) are easily rooted for artificial propagation (P. Baye pers. observ. 1991-1999). Reproductive maturity may in some cases be reached in as little as one year (P. Baye unpubl. data 1998). Flowering occurs on portions of the current year's shoot growth, usually on lateral branches of older wood. Flowers typically appear from May to October, but mostly in late summer. Occasional flowers may be found at other times of the year, sometimes emerging as early as late spring (McMinn 1939, Baye pers. observ.). Differences in flowering phenology may be an indication of genetic variation. One entire colony of Suaeda californica on Pickleweed Island, Morro Bay, was observed to flower precociously in April, while adjacent plants and all other colonies were entirely vegetative (P. Baye unpubl. data 2000). The longevity of individual plants is unknown, but large woody plants in stable substrate appear to live for over a decade. Very little information is available on the breeding system of Suaeda californica; however, a predominantly outcrossing breeding system would be expected for this wind-pollinated, often colonial, shrub. Abundant seed (many hundreds per plant) is produced on fruiting plants at Morro Bay. The ability of isolated plants in cultivation to produce seed (P. Baye pers. observ. 1998) suggests that at least some individuals possess a degree of self-compatibility. Abundant seed set occurred spontaneously in outdoor container-grown nursery plants at the Golden Gate National Recreation Area nursery in San Francisco in 1998. These seeds were viable and produced vigorous seedlings (E. Heimbinder pers. comm. 1999). Based on observations by marsh ecologist Peter Baye, abundant seedling establishment at Morro Bay appears to be episodic, corresponding to storm events that cause both vegetation gaps and deposits of driftline debris with seeds. Seedlings were widespread and abundant along the backbarrier shoreline following the erosive winter storms of 1998. Many thousands of seedlings and multiple-branched juvenile plants had established in the erosion zone in driftlines and litter rafts by late April 1998. Seedlings rooted in debris rafts without roots in the marsh substrate were subject to high mortality. No evidence of long distance dispersal and colonization was observed. Re-survey of the extensive 1998 seedling colonies in April of 1999 and 2000 revealed only regeneration of remnant mature shrubs that survived erosion. No juvenile or young mature plants were detected, indicating extremely high mortality of the post-storm cohort of seedlings. In contrast, the colonies of mature Suaeda californica at the north end of Morro Bay were mostly unaffected by the 1998 storm. These narrow, dense colonies acted as a significant refugia for survival and seed production during the catastrophic mortality that affected most of the population along the bayshore of the central sand spit (USFWS, 2013).

**Habitat Type**

Adult: Salt marsh (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from  NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species is restricted to the upper intertidal zone of a coastal salt marsh along the perimeter of a bay (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively low number of known populations.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seeds of Suaeda californica are somewhat hard-coated, and are enclosed in fleshy calyces that become spongy and buoyant upon drying, and which remain attached to the fruits after dehiscence and dispersal (USFWS, 2010).

***Population Information and Trends***

**Population Trends:**

Not available

**Number of Populations:**

Nine (USFWS, 2013)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015); ~500 (NatureServe, 2015)

**Population Narrative:**

< 500 genetic individuals estimated by McLeod (1991) as cited in USFWS 1994. (NatureServe, 2015). USFWS (2013) notes that there are nine known occurrences of this species 5 naturally occurring in Morro Bay and 4 re-introduced locations in San Francisco Bay. Low Resiliency, representation and redundancy are inferred based on the low number of occurrences and individuals as well as the small geographic range this species inhabits.

***Threats and Stressors***

**Stressor:** Alteration and Loss of Habitat (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The historical rarity of Suaeda californica in San Francisco Bay may have been due in part to the natural rarity of its sandy high marsh and beach habitat, but its extirpation seems related to the early spread of urban and port development over the East Bay shoreline from Richmond to Alameda, centered around Oakland (P. Baye pers. comm. 2004). This heavily urbanized area was the center of both the bay's sandy shorelines and S. californica distribution. Oakland and Alameda Marshes were filled and urbanized before the 20th century, eliminating populations there, but it was the destruction of Bay Farm Island for the construction of the

Oakland International Airport in the 1950s and 1960s that probably destroyed the only remaining viable population in San Francisco Bay. Other species with affinity for sandy tidal marsh edges, such as Atriplex californica, were also described as occurring either along sandy beaches or sandy marsh edges within San Francisco Bay (Brewer et al. 1880, Jepson 1911, Greene 1894). These, too, have become extirpated. The Morro Bay population has suffered little habitat loss compared with San Francisco Bay, and has relatively abundant habitat there, despite declines following El Niño winter storm erosion. However, it is subject to strong fluctuations in abundance due to natural disturbances, particularly dune migration and shoreline erosion, and its regeneration following disturbance is vulnerable to numerous threats. Though the population has in the past been threatened by strong residential and commercial real estate development pressures on the east shore of Morro Bay, centered at Baywood Park and Los Osos, these pressures have been reduced drastically (J. Vanderweir pers. comm. 2009). Loss of habitat and individuals, and failed regeneration after natural catastrophes could cause extirpation of this population. Other threats include interference by non-native vegetation, trampling, oil spills, sea level rise associated with climate change, excessive dune mobilization, and alteration of shoreline dynamics due to stabilization and shoreline repair projects (USFWS, 2013).

**Stressor:** Recruitment failure (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals/Weakening population
**Narrative:** Trampling of seedlings in Morro Bay may contribute to the failure of Suaeda californica regeneration following catastrophic shoreline erosion caused by major storms. Trampling results from both recreational activities (hiking) and by black-tail deer (Odocoileus hemionus) populations on the sand spit, and represents a relatively infrequent threat. However since seedling recruitment is episodic and local, impacts to seedlings (which are difficult to detect) could be severely detrimental at times. This is indicated by tracks and footprints along the Morro Bay shoreline in a devegetated zone nearly 0.5 meter (0.55 yd) wide (P. Baye pers. observ. 1997-1999). As recreational pressure on the Morro Bay shoreline increases with local residential population and increased visitor use at Montaño de Oro and Morro Bay State Parks, this impact is likely to become more severe (USFWS, 2013).

**Stressor:** Competition with non-native species (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Exotic invasive vegetation, primarily Carpobrotus edulis X chilensis hybrids (iceplant), Eucalyptus globulus (blue gum), and Cupressus macrocarpa (Monterey cypress; a native to the Monterey peninsula only), cause significant damage to Suaeda californica by direct interference and indirect adverse habitat modification. Carpobrotus edulis establishes clonal colonies in adjacent uplands above saline influence, and can encroach by transporting nonsaline soil moisture from portions of the clone above the high tide line (P. Baye unpubl. data 1997). Most stands of S. californica along the perimeter road to Morro Beach State Park have been partially smothered by C. edulis, which grows through and over the S. californica colonies there. Carpobrotus edulis impacts are particularly significant for seedling regeneration along the backbarrier shore of Morro Bay spit. As the sandy backbarrier shoreline retreats into dense continuous stands of C. edulis on the dunes, C. edulis overhangs the erosional scarp and forms a canopy that drapes over the base of the scarp and upper shoreline. This sharply reduces or

eliminates open seedling habitat for S. californica—its regeneration niche. It may also inhibit regeneration of storm-eroded remnants of S. californica. Therefore, spread of C. edulis along the dunes of the backbarrier shoreline is likely to reduce population resilience of S. californica. In fact, removal of C. edulis near S. californica populations has had a striking effect of recovery of the later (Baye in litt. 2009). Heavy leaf litter and canopy shade from non-native trees, Cupressus macrocarpa and Eucalyptus globulus, are detrimental to seedling habitats for Suaeda californica, and apparently cause decline in vigor of remnant stands of mature plants (e.g., near the entrance of Morro Bay State Park and in Baywood Park). Degradation of the ecological niche for seedling regeneration is probably a more severe long-term threat to the viability of the S. californica population than local disturbance of existing mature colonies. Stands of S. californica have been damaged directly by broken and fallen limbs of E. globulus adjacent to Morro Beach State Park (P. Baye unpubl. data 1997-2000). The persistence of suitable and restorable habitat for reintroduction of Suaeda californica to San Francisco Bay is also threatened by non-native vegetation. In San Francisco Bay, the spread of invasive Spartina (Daehler and Strong 1996) caused the conversion of open mudflat into stabilized tidal marsh that traps sediment and moderates estuarine wave energy. This invasive vegetation intercepted alongshore transport of sand in the middle and lower intertidal zone, and inhibited the wave deposition of the sandy higher elevation marsh-beach ecotone that is important for establishment of S. californica. Invasive Spartina eradication efforts have likely eliminated the further spread of the species which could have precluded the long-term viability of S. californica reintroduction (USFWS, 2013).

**Stressor:** Dredging (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Navigational dredging may threaten stands of Suaeda californica that have colonized the marina shoreline at Morro Bay State Park. Dredging of the inlet channel steepens the subtidal shore profile, probably resulting in shoreline erosion along the unarmored eroding south shore of the interior shoreline of the marina, which could threaten the S. californica colony there. The marina subpopulation of S. californica is particularly significant to the species' conservation because it is highly sheltered from storm wave erosion that threatens the main population along the spit's backbarrier shoreline (USFWS, 2013).

**Stressor:** Predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** In the absence of natural predators, hunting, or management in Morro Bay, deer populations are likely to forage intensively along the backbarrier shoreline where seeps provide fresh water, soft herbaceous vegetation, and flat travel corridors (USFWS, 2013).

**Stressor:** Small number of populations (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Extirpation
**Narrative:** Suaeda californica is vulnerable to extinction in the wild largely because it has been reduced to a very small number of populations distributed in a very narrow zone of the Morro

Bay and San Francisco Bay shorelines. In Morro Bay, most of the colonies occur along the erodible backbarrier shore of the Morro Bay sand spit, which is susceptible to erosion by occasional extreme storm tides and high wind-generated waves, and rapid burial by migrating dunes. Severe storm erosion occurred along this shoreline in the winter of 1997-1998, creating an extensive erosional scarp in the narrow S. californica zone. The population has not yet rebounded from this event. Although this was a natural catastrophe and rebound may occur in time, erosion events may become a recurrent threat if climate change increases storm intensity, frequency, and sea level rise rates (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/extirpation
**Narrative:** Extreme local fluctuations of climate (winter storms, high winds, summer drought) may be associated with global climate change. A series of severe winter storms followed by years of drought could cause catastrophic reproductive failure of the species. Global climate change and associated sea level rise may also cause long-term changes in the stability of sand beach and dune shorelines (SCOR Working Group 1991), such as those of Morro Bay spit. Suaeda californica occurs in abundance only where the backbarrier shoreline is adjacent to dune scrub vegetation that stabilizes dunes. It is sparse or absent where bare mobile dunes retreat over the backbarrier shoreline. Many of the remaining colonies are being encroached on by mobile dunes, and are not expected to survive more than a few years. The formation of new “marsh coves” (potential S. californica habitat) in the lee of stabilizing dunes may occur in the future, but none are foreseeable now. A combination of shoreline retreat and increased dune movement could significantly reduce the largest subpopulation of S. californica. Accelerated sea level rise and shoreline retreat could also force conflicts between natural movement of the Suaeda californica zone on the east shore of Morro Bay and landowner needs. Where costly residential developments are threatened by shoreline retreat, response typically involves armoring (structural stabilization) of the shoreline (e.g., revetments, seawalls, rip-rap, etc.). Currently, S. californica appears to be able to migrate with the slowly retreating shorelines of eastern Morro Bay (Baywood Park, heron rookery) (USFWS, 2013).

**Stressor:** Oil spills (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/extirptation
**Narrative:** Oil spills and clean-up operations may have significant adverse effects on Suaeda californica populations at Morro Bay, particularly on seedlings. Spilled oil tends to accumulate near the high tide line, the narrow marsh zone in which S. californica is largely restricted. Oil would probably cause high mortality of seedlings and juvenile plants during years of seedling regeneration by coating and smothering small plants with oil, and possibly by direct toxicity. Oil clean-up operations involving mechanical removal (raking, excavation) of oiled sand would also cause significant disturbance of S. californica habitat. Direct toxic effects of oil on older woody S. californica are uncertain, but are probably less damaging than effects of clean-up operations (USFWS, 2013).

**Stressor:** Rust Disease (USFWS, 2023)
**Exposure:**

**Response:**
**Consequence:**
**Narrative:** Researchers collected and identified a new species of rust fungus (Uromyces rebeccae) on California seablite plants from Morro Bay (Bruckart et al. 2020, pg. 546). In general, rust disease on plants may cause leaf chlorosis (yellowing), withering, and premature abscission (falling off). Heavy rust infestation reduces overall vigor and extreme cases may kill plants (Royal Horticultural Society 2023, website). Rust disease on California seablite is a new threat to the species (USFWS, 2023).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 8

1. Within the Morro Bay Recovery Unit, dunes are revegetated with native species to achieve natural shoreline stability consistent with that which existed in historic dune systems. (USFWS, 2023)

2. Eradication of iceplant (Carpobrotus edulis) is conducted throughout habitat for California seablite at the Morro Bay Recovery Unit. (USFWS, 2023)

3. Habitat supporting at least three populations in the Central/South San Francisco Bay Recovery Unit must exist on land in conservation ownership or under conservation management. (USFWS, 2023)

4. To provide sufficient resilience to stochastic events, all conditions under downlisting criteria 1 through 3 (above), have been met and have resulted in at least the following: a. Number of populations: a minimum of three populations must occur in the Morro Bay Recovery Unit and a minimum of three populations must occur in the Central/South San Francisco Bay Recovery Unit. A population shall be any concentration of plants separated by greater than 1.9 km (1.2 miles) from other such concentrations of plants, with no intervening locations observed over a period of five years. b. Number of plants: minimum – for five consecutive years of monitoring, the three populations in the Morro Bay Recovery Unit must total a minimum of 3,000 individuals. c. For five consecutive years of monitoring, the three populations around the San Francisco Bay must total a minimum of 1,500 individuals. (USFWS, 2023).

**Delisting Criteria:**
1) protection of the population at Morro Bay to ensure its long-term survival (USFWS, 2013).

2) re-establishment of suitable habitat with new populations in San Francisco Bay, the historical range of the species

**Recovery Actions:**

- 1. Any person collecting information on Suaeda californica as part of field surveys or research should be encouraged to submit occurrence information to the CNDDB to provide a more comprehensive picture of this species distribution and status throughout its range (USFWS, 2010).

- 2. Potential re-introduction sites for Suaeda californica within the San Francisco Bay area and other sites within its historic range should continue to be evaluated by the Service (USFWS, 2010).
- 3. Land managers and the Service should work cooperatively to begin population surveys in all potentially suitable and legally-accessible habitat along the central coast to determine if there are yet undiscovered occurrences of Suaeda californica and to update the status of known occurrences (USFWS, 2010).
- 4. The CDPR and the Service should continue monitoring of existing outplanting efforts and seek to identify additional sites for outplanting of Suaeda californica on Federal, State, or otherwise conserved lands along the coastline in San Luis Obispo County (USFWS, 2010).
- 5. Establish site-specific and species monitoring protocols to identify potential impacts of sea-level rise and storm surge associated with climate change. This will assist in determining the effects of projected sea level rise and increased storm surge events on Suaeda californica and its habitat (USFWS, 2010).
- 6. The CDPR and Morro Coast Audubon Society should develop and implement active nonnative invasive species eradication programs for those occurrences of Suaeda californica under their management authority. Post-eradication, sites should be evaluated for their potential to re-establish occurrences of S. californica (USFWS, 2010).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access (if possible) to all known/mapped California seablite occurrences to conduct monitoring surveys of the status, abundance, approximate size and age of plants observed, and evaluate threats at these locations. Include estimates of numbers of individuals present, global positioning system (GPS) mapping of occupied spatial area, ecological setting, co-occurring and co-dominant vegetation, presence of natives versus nonnative plant species, timing of phenology, soils and hydrological data, and observations of potential insect pollinators. Update information in resource agency databases (CNDDB) to ensure that these data remain accurate and current. 2. Develop site-specific, comprehensive management plans for California seablite occurrences designed to ameliorate the species threats, and ensure that progress towards achieving the recovery criteria outlined in the recovery plan is made, so that the criteria are ultimately met. 3. Ensure that partners at all occurrences conduct invasive weed reduction and elimination activities, with special attention toward eradication of ice plant. If necessary, dune restoration efforts should also occur, focusing on outplanting of native species to achieve natural shoreline levels of stability and curtail erosion. 4. Conduct experimental research on the species population genetic structure. Assess the genetic constitution of colonies within Morro Bay and levels of connectivity between them. Then compare these data with outplanted colonies in the San Francisco Bay Area to determine if genetic diversity in the species is maintained, if new variations occurred, and other potential effects from outplanting. Genetics work to assess the overall ability of California seablite to withstand stochastic events also needs to occur. 5. Continue experimental research on the reproductive biology of the species. In particular, we need to better understand California seablite’s capacity to both outcross and self, the degree that it is utilizing these different pathways in the wild, identify insect pollinators (if they are being used), and the possible implications of these factors on the species recovery. 6. Make accessions for conservation seed banking throughout the species range, so all occurrences are represented in the collections. Conduct seed bulking of accessions that may serve as a source for recovery efforts, and a backup in the event of stochastic loss and local extirpation. (USFWS, 2023)

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# SPECIES ACCOUNT: *Thalictrum cooleyi* (Cooley's meadowrue)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 02/07/1989; Southeast Region (R4) (USFWS, 2017)

**Physical Description**

A small, rhizomatous, perennial herb with erect to lax stems, up to 1 m tall. Loose clusters of flowers are borne in June. The unisexual flowers lack petals, but the sepals are white, pale yellow, or pale green with lavender filaments. The leaves are narrow and lance-shaped. The fruits are single-seeded and winged. Phenology: Flowers appear mid to late June and fruit mature in August or September (NatureServe, 2015).

**Taxonomy**

Thalictrum cooleyi is distinguished from other such members of the genus, Thalictrum revolutum in particular, by the combination of leaflet narrowness (4 to 26 times as long as wide), lack of lobing in the majority of the leaflets, and absence of hairs, glands, or papillae on lower leaflet surfaces, petioles, peduncles, and achenes (Park 1992) (USFWS, 1994).

**Historical Range**

Three historic North Carolina populations--Brunswick, Columbus, and Pender Counties--are assumed extirpated, because recent surveys showed habitat destruction at the sites and no plants were found (North Carolina Natural Heritage Program 1992). Cooley's meadowrue has been reported from New Hanover County, North Carolina (Radford et al. 1968), but without documentation (USFWS, 1994).

**Current Range**

All of the known Thalictrum cooleyi populations occur in the Coastal Plain Province in NC, GA, and FL (USFWS, 2009).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual, wind- and insect-pollinated (NatureServe, 2015)

**Breeding Season**

Adult: Flowering in June (Radford et al, 1968) (NatureServe, 2015)

**Reproduction Narrative**

Adult: Flowering in June (Radford et al, 1968). The winged, single-seeded fruits mature in August and September (Lowe et al. 1990), but the seed life is presumably short. A dioecious species, Thalictrum cooleyi has separate male and female flowers that are wind- and insect-pollinated (NatureServe, 2015).

**Habitat Type**

Adult: Pine Savanna (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Wetlands/intermittent fire (NatureServe, 2015; USFWS, 1994); soil pH 5.8-6.6 (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1994)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1994)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Sunny, moist places such as open, savanna-like forest edges and clearings, wet savannas over calcareous clays, and ecotones between wet savannas and non-riverine swamp forests. Soils are basic, sandy loams. Also on roadsides and power line rights-of-way in former savannas. It grows on circumneutral soils in wet pine savannas, grass-sedge bogs, and savanna-like areas, often at the border of intermittent drainages or swamp forests. Boggy savannah-like borders of low woodlands, roadside ditches, and power line rights-of-way. Usually associates with some type of disturbance, e.g., clearings, the edges of frequently burned savannas, power line right-of ways which are maintained either by fire or mowing, and roadside edges. Typically on Grifton soil. This plant is found on fine sandy loams that are at least seasonally (winter) moist or saturated and are only slightly acidic (pH 5.8-6.6). Sufficient moisture is critical to plant vigor and reproductive effort. This plant occupies a narrow hydrological niche, where soil is moist to saturated but water does not stand above the soil surface. This species occurs in moist to wet bogs and savannas and savanna-like openings on circumneutral soils and is dependent upon some form of disturbance to maintain the open quality of its habitat. Currently, artificial disturbances, such as power line and road right-of-way maintenance, and plowed firebreaks, are maintaining some of the openings historically provided by naturally occurring periodic fires (Murdock 1989).This species grows in circumneutral soil in moist to wet savannas and savanna-like areas kept open by frequent fire or other disturbance. "This borderline type of habitat would have been disturbed historically by naturally occurring savanna fires moving through at 1- to 5-year intervals, clearing litter from the soil surface and causing the cyclical advance and retreat of woody growth. A typical population of Cooley's meadowrue has robust reproductive plants among shrubs and in adjacent open savanna and repressed individuals in nearby dense shade" (Boyer 1994) (NatureServe, 2015; USFWS, 1994). Low tolerance range and clumped spatial arrangement are inferred based on the specific habitat needs of this species and the relatively low number of populations (NatureServe, 2015; USFWS, 1994).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low (USFWS, 1994)

**Dispersal/Migration Narrative**

Adult: Possibly propagate by breaking off and dispersal of vegetative parts in aquatic habitat (USFWS, 1994).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Species Trends:**

Stable (USFWS, 2009)

**Number of Populations:**

19 (USFWS, 2020)

**Population Size:**

1 - 1000 total individuals (NatureServe, 2015)

**Population Narrative:**

Thalictrum cooleyi is intrinsically vulnerable in several ways. It is rhizomatous, so the number of ramets is far greater than the number of genets. It is dioecious, so the populations where only one sex persists are particularly vulnerable. It produces few seeds and apparently does not have a seed dispersal mechanism (USFWS 1989). (NatureServe, 2015) The total number of individuals is estimated at between 1 and 1000 and the number of populations between 6 and 20. In addition, the short-term population trend indicates a decline of 10-30% (NatureServe, 2015). Low representation, resiliency and redundancy are inferred based on species specific habitat needs, low number of populations and fragmentation of suitable habitat (NatureServe, 2015). In the 2008 Recovery Data Call, the status of Thalictrum cooleyi was listed as stable. Between 2005 and 2007, NCNHP staff or other knowledgeable botanists have visited 12 of 25 North Carolina subpopulations (representing 10 populations) of Thalictrum cooleyi. As of 2008, there were 9 extant populations in NC; 2 in GA; and 1 in FL (USFWS, 2009). In summary, several new EOs have been found in NC, including one entirely new population and four EOs that expand the size of a known population. One new discovery is a county record for New Hanover County, NC; however, it is located within a few hundred feet of the boundary with Pender County, where this species has been known since listing. One new population was discovered in Worth County, GA. Currently, state natural heritage programs recognize 19 extant populations (10 in NC, 8 in GA and 1 in FL). Of these, 10 populations (6 in NC, 3 in GA and 1 in FL) have some level of protection, and are either owned and/or managed for conservation by state agencies or private conservation organizations. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Agriculture (USFWS, 1994)
**Exposure:**

**Response:**
**Consequence:** Loss of habitat
**Narrative:** USFWS (1994) notes that land clearing for agriculture is a threat to this species.

**Stressor:** Succession (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** USFWS (1994) notes that succession (due to lack of disturbance/fire) is a threat to this species.

**Stressor:** Forestry (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** USFWS (1994) notes that forestry/logging is a threat to this species.

**Stressor:** Mining and Development
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** USFWS (1994) notes that mining and development are threats to this species.

**Stressor:** Draining (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** USFWS (1994) notes that draining (for development/road construction) is a threat to this species.

**Stressor:** Road construction (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** USFWS (1994) notes that highway construction is a threat to this species.

**Stressor:** Inadequacy of regulatory mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There are no known populations on federal lands (USFWS, 2009).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 2

**Delisting Criteria:**
Cooley's meadowrue (Thalictrum cooleyi) will be considered for delisting when there are at least 16 self-sustaining, geographically distinct populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks (USFWS, 1994).

**Recovery Actions:**
- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners and managers. Search for additional populations and potential habitat. Rank populations for focus of protection efforts. Evaluate habitat protection alternatives (USFWS, 1994).
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Determine population size, stage-class distribution and sex ratios for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in suitable habitat within the species' historic range (USFWS, 1994).
- Maintain and expand cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1994).
- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats; discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2009).
- Search for additional populations (USFWS, 2009).
- Prioritize known sites for protection (USFWS, 2009).
- Protect additional populations (USFWS, 2009).
- Develop management plans for all protected populations (USFWS, 2009).
- Develop monitoring protocols, initiate long term population monitoring and determine the criteria for sustaining populations (USFWS, 2009).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2009).
- Compare, genetically, the populations of questionable taxonomy in Georgia with those known from North Carolina and Florida (USFWS, 2009).
- Work with North Carolina Botanical Garden to conserve seeds and develop propagation protocols (USFWS, 2009).

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed in the 2009 5-year review (page 10 and 11 above) remain important to the conservation and recovery of Thalictrum cooleyi. Since the 2009 5-year review, progress has been made on several recommendations for

future actions. For example, the Service and East Carolina University professors and graduate students have visited most of the known populations in NC and provided updated information to the NCNHP. According to GADNR and FLNAI records, half of the known populations in GA and the single FL population have been visited since the last 5-year review and natural heritage program records have been updated. Surveys for new populations of Thalictrum cooleyi have resulted in the discovery of one new population in New Hanover County, NC and one new subpopulation was discovered near a known population in Pender County, NC. In addition, a new population was discovered in Worth County, GA. Additional surveys across the range of the species are needed and may result in the discovery of new populations. Such surveys could be guided by species distribution modeling. Researchers at East Carolina University recently conducted research on various aspects of the life history and reproductive biology and genetics of Thalictrum cooleyi. Their research also increased our knowledge of the propagation and culture of this species which will be used to guide future restoration efforts. (USFWS, 2020)

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# SPECIES ACCOUNT: *Thelypodium howellii spectabilis* (Howell's spectacular thelypody)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Howell's spectacular thelypody is an herbaceous biennial that reaches approximately 60 cm (24 inches) tall, with branches arising from near the base of the stem. The basal leaves are approximately 5 cm (2 inches) long with wavy edges and are arranged in a rosette. Stem leaves are shorter, narrow, and have smooth edges. It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August (USFWS, 2016).

**Current Range**

Endemic to the northeastern corner of Oregon, occurring in the Baker-Powder River valley in Baker and Union Counties (Fish and Wildlife Service 1999). Generalized current range of about 175 sq. km.

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated (USFWS, 2016)

**Breeding Season**

Adult: Flowers in May (USFWS, 2016)

**Reproduction Narrative**

Adult: It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August (USFWS, 2016).

**Habitat Type**

Adult: Wet alkaline meadows (USFWS, 2016)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2016)

**Habitat Narrative**

Adult: The thelypody occurs in wet alkaline meadows in valley bottoms, usually in and around woody shrubs that dominate the habitat on the knolls and along the edge of the wet meadow habitat between the knolls. Soils are pluvial-deposited alkaline clays mixed with recent alluvial silts, and are moderately well-drained (Kagan 1986). Associated species include Sarcobatus vermiculatus (greasewood), Distichlis stricta (alkali saltgrass), Elymus cinereus (giant wild rye), Spartina gracilis (alkali cordgrass), and Poa juncifolia (alkali bluegrass) (Kagan 1986). The thelypody may be dependent on periodic flooding since it appears to rapidly colonize areas adjacent to streams that have flooded (Kagan 1986). Abundance fluctuates widely from year to year in response to annual climate and soil moisture (USFWS 2010, p. 4). Thelopody is readily consumed by cows. Thus, thelopody is typically only found under shrubs in areas that are intensively grazed during the growing season (USFWS 2010). In addition, this taxon does not compete well with encroaching weedy vegetation such as Dipsacus fullonum (teasel) (Davis and Youtie 1995) (USFWS, 2016).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Unknown (USFWS, 2016)

**Number of Populations:**

5 natural populations (13 sites). 1 introduced population (USFWS, 2023)

**Population Size:**

10,000 - 100,000 individuals (USFWS, 2016)

**Population Narrative:**

This taxon was thought to be extinct until rediscovered by Kagan in 1980 near North Powder (Kagan 1986a). The Recovery Plan identifies 11 different occurrences that are grouped into five separate “populations” The labeling of these geographically-clustered occurrences as “populations” is a loose application of the term, since we do not know the extent of genetic interchange among occurrences. The 2008 update of the Oregon Natural Heritage Information Center’s (ORNHIC) database documents 15 Howell’s thelypody occurrences (USFWS 2010). The known occurrences vary substantially in size and plant abundance. Some are small patches just several hundred square feet in size, while others extend over 10 to 20 acres. One additional population has been established since the subspecies was listed. Staff from ODA’s Native Plant Conservation Program translocated thelypody plants to three locations near Baldock Slough on a property that has a permanent conservation easement through the Wetland Reserve Program (Currin et al.2008). All of the known thelypody occurrences are on private land and many are not accessible for monitoring. Since Federal listing in 1999, population monitoring efforts have focused on three sites where there are mechanisms in place that allow for thelypody monitoring: 1) the Haines Rodeo Grounds site, 2) the Miles Ranch Easement, and 3) the Baldock Slough introduction site (USFWS 2010). At all of the monitored sites, the number of flowering plants tends to vary widely from year-to-year. The amount of early spring precipitation appears to be an important driver of annual abundance, with high precipitation levels correlated with increased plant abundance. The biennial habit of thelypody also appears to play a role, with spikes in abundance tending to occur every two years (J. Stephenson, USFWS, pers. comm., 2015). In one ½-acre plot at the Haines Rodeo Grounds that was intensively monitored from 2008 to 2010, thelypody abundance fluctuated from 3,011 plants in 2008 to 25,600 plants in 2009, and back down to 3,135 plants in 2010 (EcoWest Consulting 2011). As this is a protected site, no livestock grazing or other land use activities occur that might negatively affect plant development. The inherent year-to-year variability in plant numbers make it difficult to assess long-term population trends, particularly since quantitative surveys are not conducted every year (J. . Stephenson, USFWS, pers. comm., 2015). During good years, the Haines Rodeo Grounds population is quite large (> 50,000 plants in 2009), however few plants were found during qualitative surveys in June 2014 leading to concerns that this population is declining. There is concern that the spread of invasive weeds, particularly cheatgrass, is outcompeting thelypody in this area. There is less quantitative survey data for the Miles Ranch Easement, but it is also a large population in good years (> 35,000 plants in 2009). The Baldock Slough introduced population contained approximately 400 plants in 2009, distributed in 7 small areas. By 2013, plants were found at only 3 of the 7 areas, and a survey in June 2014 tallied only 20 plants in those 3 remaining areas (D. Trochlell, Natural Resource Conservation Service, pers. comm. 2014). The other known thelypody locations are all located on private lands have either very limited or no access to the occupied sites (USFWS 2010). Where occurrences are visible from public roads, occasional presence/absence surveys have been done in June/early July (when flowering plants are highly visible) to document that the occurrence is still extant, while the less visible sites have not been observed in many years. Much uncertainty remains given the inability to access and monitor the majority of populations on private lands that have no special management protections. However, the overall status of thelypody has improved since listing because additional populations have been found and 3 populations have some protections in place for thelypody. The protection of these sites and some modest progress in developing compatible livestock grazing management practices have moved these subspecies further away from the threat of extinction (USFWS 2010) (USFWS, 2016). Surveys 0 Additional population information was collected in 201 1 (Oregon Department of Transportation 2013), where State highway crews documented approximately 35 plants growing on the side of Highway 84. This population had been documented previously in 2009, 1997 and 1996, is within the previously described range, and is located 0.15 miles from another population. 0 USDA-NRCS conducted a survey of seven sites on June 25, 2014. In four of the . seven experimental sites where the Oregon Department of Agriculture Native Plant Conservation Program had conducted transplants in 2002 and 2007, no T howellii ssp. spectabilis were found. USDA-NRCS attributed this decline to a competition from nonnative species including intermediate wheatgrass (Thinopyrum intermedium) and whitetop (Cardaria draba), which were thought to be outcompeting T. howellii ssp. spectabilis (U.S. Department of Agriculture- Natural Resource Conservation Service 2014) (USFWS, 2018). Research 0 In 2014, EcoWest Consulting Inc. and the USFWS finished an experiment titled “The influence of Population Dynamics, Grazing, and Precipitation Patterns on the Restoration of a Threatened Riparian Mustard to Former Habitat” (2014). Thelypodium howellii ssp. spectabilis was the subject of this Before/After Control/Impact (BACI) design study, which began in 2008 and concluded in 2014. The results of the study were largely inconclusive due to the life history and moisture and soil sensitivity of T. howellii ssp. spectabilis, which resulted in highly variable results. However, the researchers suggest that changes in grazing practice to late season grazing after post-seed dispersal may allow these plants to expand into other areas (USFWS, 2018). Howell’s spectacular thelypody, a biennial plant in the mustard family, continues to occur within the geographic area identified in the recovery plan - the Powder Valley between North Powder, Haines, and Baker City in Union and Baker Counties, Oregon. The recovery plan described five Figure 1: Map of Howell's spectacular thelypody populations. Marshall and Brown (2021). Used with permission. natural populations, consisting of 13 sites (Figure 1), plus one introduced population at Baldock Slough (not mapped – located between North Baker and North Powder populations) (USFWS, 2023).

### *Threats and Stressors*

**Stressor:** Development (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Habitat loss due to urban and agricultural development is listed as a threat to this species (USFWS, 2016).

**Stressor:** Habitat degradation (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Habitat loss/habitat degradation
**Narrative:** Habitat degradation due to livestock grazing and hydrological modification is listed as a threat to this species (USFWS, 2016).

**Stressor:** Grazing (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Consumption by livestock is listed as a threat to this species (USFWS, 2016).

**Stressor:** Herbicides (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of indivduals
**Narrative:** Use of herbicides or mowing during the growing season is listed as a threat to this species (USFWS, 2016).

**Stressor:** Competition (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Competition with exotic species such as teasel (Dipsacus fullonum), bull thistle (Cirsium vulgare), Canada thistle (C. canadensis), and yellow sweet clover (Melilotus officinalis) is listed as a threat to this species (USFWS, 2016).

### *Recovery*

**Reclassification Criteria:**
Recovery Priority Number: 8

**Delisting Criteria:**

The thelypody recovery plan calls for the protection of five self-sustaining thelypody populations throughout its extant and historic range. Each of the five populations should have management plans providing for the plant's long-term protection and have stable or increasing trends for 10 years. Currently, three populations of thelypody receive some level of protection from development and are managed for conservation (USFWS 2010). The Haines Rodeo Grounds is a purchased mitigation site specifically for thelypody conservation, and has a completed management plan for this species. The other two sites (the Miles Ranch Easement and the Baldock Slough introduction site) are easements managed for wetlands protection. While the Baldock slough will remain protected in the Wetland Reserve Program, it is not clear if the reintroduced population will become self-sustaining. In addition, there are also three small roadside populations managed by ODOT under a State Management Area. In the past, there were two populations on private lands near North Powder that were managed via conservation easements: the BLM has managed a population for several years until about 2006, and the TNC managed another population for 15 years. At this time there are no agreements for the management of these two populations and their status is unknown (USFWS, 2016).

**Recovery Actions:**

- Landowner Outreach — Work with local officials in Baker and Union counties to develop a Thelypody Conservation Proposal that includes participation incentives that would then be taken to landowners in thelypody habitat for their consideration. Such a proposal would likely include provisions for establishment of pastures with special management elements for thelypody conservation (e.g., rest or reduced grazing during the growing season) (USFWS, 2018).
- Grazing Research — Continue controlled studies to determine the response of thelypody to livestock grazing outside the plant's primary growing season, as well as the potential to use grazing as a tool to control competing vegetation (USFWS, 2018).
- Manage Haines Rodeo Grounds Site — Work with the Baker County Road Department to reinitiate implementation of the management plan for this site. Of particular concern at this site is control of competing vegetation in thelypody-occupied areas (USFWS, 2018).
- Management Plan for Miles Easement — Finalize a management plan for the Miles Easement and actively pursue its successful implementation (USFWS, 2018).
- Succeed at Baldock Slough — Continue the effort to successfully establish a the lypody population at Baldock Slough. Control of invasive weeds will need to be a key component of this effort (USFWS, 2018).
- Monitoring Plan — Develop and use a practical, standardized methodology for monitoring thelypody populations so that we can obtain comparable data across sites and across years. This methodology would also serve as the basis for a subsequent Post Delisting Monitoring Plan, satisfying one of the delisting criteria in the Recovery Plan (USFWS, 2018).
- All of the General Plant Conservation Measures (Section 3.13.1) apply for thelypody. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Howell's spectacular thelypody, unless approved by the local Service office (USFWS, 2016).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: ⍰ Stakeholder engagement and landowner outreach – Create a stakeholder group, in cooperation with ODA, to increase communication and action on thelypody conservation programs and promote community interest and involvement in the protection of this rare plant, and to help inform management plans. Partner with local officials in Baker and Union counties to develop a Thelypody Conservation Proposal that includes participation incentives that would then be taken to landowners in thelypody habitat for their consideration.  Management of Haines Mitigation Site – Work with Baker County to update and reinitiate implementation of the management plan for this site and reinitiate its implementation. Of particular concern at this site is control of competing vegetation in thelypody-occupied areas.  Management Plan for Miles Easement – Develop and finalize a management plan, in cooperation with ODA and the land owner, for the Miles Easement and actively pursue its successful implementation. Prioritize monitoring of this site.  Regular monitoring at a subset of sites – Future monitoring should include a full thelypody population count (or sampling where appropriate) and mapping at least every two to four years at a subset of strategically selected sites. This will aid in understanding year to year population variability and population stability, along with changes in the spatial distribution of plants in wet versus dry conditions. Vegetation monitoring transects at Haines Mitigation Site (re-surveyed in 2023) should be repeated to better understand the changing plant composition over time.  Succeed at Baldock Slough – Continue the effort to successfully establish a thelypody population at Baldock Slough. Site preparation and control of invasive weeds, especially whitetop (Lepidium draba), will need to be a key component of this effort.  Continue the Seed-Increase Program – Continue to collect wild thelypody seed and bulk the seed by growing it over the full life cycle (i.e., 2 years to flower and set seed) in a greenhouse setting. Seeds should be collected following both wet and dry years to increase genetic diversity and resilience of the species to climate variability. Consideration should be given to the life expectancy of thelypody seeds, as viability may decrease with time. Seed should be collected from multiple sites and grown at more than one facility to improve representation and redundancy.  Introductions on protected land – Explore options for population introduction at protected sites. Seek out potential sites that support the associated alkali plant community and have adequate hydrology. An analysis of soil composition and hydrology, along with invasive species management and site preparation, is recommended prior to population introduction.  Research unknowns and emerging issues - Climate change is an emerging threat for most rare species, and Howell’s spectacular thelypody may be particularly at risk due to its need for moisture and small geographical range. Research needs include determining what constitutes a “stable” population, including year to year variation in population size and distribution, and response to precipitation, temperature, and groundwater. Research seed viability and longevity (both in storage and in the wild), and continue research into grazing effects.  Consider updating the recovery plan – After implementing the above recommendations and reviewing monitoring data and new research, consider whether to update the 2002 recovery plan using the new 3-part planning process (USFWS, 2023).

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# SPECIES ACCOUNT: *Thymophylla tephroleuca* (Ashy dogweed)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 07/19/1984; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

Ashy dogweed is endemic to South Texas and occurs in open flat areas of shrubby grasslands and deep sandy pockets of fine sandy loam soils. Ashy dogweed is a short, woody-based, perennial sub-shrub plant, growing 3.9 – 11.8 inches in height and belongs to the Asteraceae (sunflower) family. It has mostly alternate, linear leaves with ashy-white pubescence due to fine, short hair glands that emit a pungent odor when crushed (U. S. Fish and Wildlife Service 1988). Flower heads are yellow to bright yellow and flowering typically occurs between March and May; however, such events are dependent on rainfall (USFWS 1984) and can occur as early as February (Correll and Johnston 1979). Ashy dogweed is an obligate out-crosser that has non-specialist pollinators from members of the families Buprestidae (beetles), Bombyliidae (bee flies), and Megachilidae (bees) (Dodson 2001, Williamson 2002, Poole et al. 2007).

**Current Range**

Several ashy dogweed populations are considered meta-populations based on relative distance between sites. Surveys conducted in the years since listing have identified five other extant populations in addition to the one known at the time of listing. These populations have increased the known range of the species from Webb to southern Zapata County. The loss, fragmentation and/or alteration of habitat may be increased at these meta-population sites as opposed to plants in populations that are farther apart. Ashy dogweed was first recorded in Starr County in 1932, near Rio Grande City, but is now considered extirpated from this area. This species was federally listed as endangered on July 19, 1984 and a recovery plan for the species was completed in 1988. At the time of listing, the ashy dogweed population was estimated to be 25 acres in size and contained approximately 1,300 individuals (USFWS 1984, 1987). Since then five additional populations have been found and the species' known range has expanded from Webb County into Zapata County, Texas (USFWS 2011). One of the six extant populations is partially on state-owned ROW lands that are maintained by TxDOT. The five remaining populations are found on private lands and three of the land owners have entered into Voluntary Conservation Agreements with TPWD (USFWS 2011). No critical habitat has been designated for ashy dogweed.

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproduction Narrative**

Adult: Flower heads are yellow to bright yellow and flowering typically occurs between March and May; however, such events are dependent on rainfall (USFWS 1984) and can occur as early as February (Correll and Johnston 1979). Ashy dogweed is an obligate out-crosser that has non-specialist pollinators from members of the families Buprestidae (beetles), Bombyliidae (bee flies), and Megachilidae (bees) (Dodson 2001, Williamson 2002, Poole et al. 2007).

**Habitat Type**

Adult: Grasslands

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Fine sand or sandy-loam soils on level or rolling grasslands that are often shrub-invaded. Freer mixed brush thorn woodland. Mesquite-Acacia thorn woodland. (NatureServe, 2015). Ashy dogweed is endemic to South Texas and occurs in open flat areas of shrubby grasslands and deep sandy pockets of fine sandy loam soils.

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

6 (USFWS, 2022)

**Population Narrative:**

Several ashy dogweed populations are considered meta-populations based on relative distance between sites. Surveys conducted in the years since listing have identified five other extant populations in addition to the one known at the time of listing. These populations have increased the known range of the species from Webb to southern Zapata County. The loss, fragmentation and/or alteration of habitat may be increased at these meta-population sites as opposed to plants in populations that are farther apart. Ashy dogweed was first recorded in Starr County in 1932, near Rio Grande City, but is now considered extirpated from this area. This species was federally listed as endangered on July 19, 1984 and a recovery plan for the species was completed in 1988. At the time of listing, the ashy dogweed population was estimated to be 25 acres in size and contained approximately 1,300 individuals (USFWS 1984, 1987). Since then five additional populations have been found and the species' known range has expanded from Webb County into Zapata County, Texas (USFWS 2011). One of the six extant populations is partially on state-owned ROW lands that are maintained by TxDOT. The five remaining populations are found on private lands and three of the land owners have entered into Voluntary Conservation Agreements with TPWD (USFWS 2011). No critical habitat has been designated for ashy dogweed. At the time of the 5-year status review in 2011, six extant populations were known (Service, 2011). Three occur on private lands and one large extant meta-population partially occurs along the TXDOT U.S. Highway 83 right-of-way (ROW) on both state- and privately-owned lands (USFWS, 2022).

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Primary threats to the survival of the ashy dogweed have been identified as certain ranching activities, including invasion by non-native grasses planted to improve range conditions. Oil and gas development, highway development and roadside projects, and climate change (e.g. more frequent and/or extended droughts) also threaten the species.

**Stressor:** Habitat Loss
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat loss for ashy dogweed has been largely due to the introduction of non-native pasture grass during the conversion of native rangeland to improved pasture; overgrazing; and ground disturbance activities associated with urban development, construction or improvement of highways and utility transmission systems necessary to support urban infrastructures

**Stressor:** Introduction of non-natives
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Many areas in South Texas are dominated by the introduced buffelgrass (Pennisetum ciliaris), an aggressive, exotic grass. Kleberg bluestem grass (Dicanthium annulatum), used for erosion control on roadway ROWs, also invades natural areas and is present at all ashy dogweed sites although not as extensively as buffelgrass (USFWS 2011).

**Stressor:** Drought
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drought conditions can reduce plant populations and population size, decreasing genetic variability and viability, thus reducing the species ability to cope with a wide range of environmental stressors (USFWS 2011).

**Stressor:** Grazing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Seedling establishment can be decreased by chaining, blading, dozing and disking activities that cause deep soil disturbance, along with surface compaction (Williamson 2002) potentially caused by heavy grazing pressures (USFWS 1988). Dodson's (2001) and Williamson's (2002) research suggests that some disturbance may be important for this species' colonization, spread, and/or growth; however, the level of preferred disturbance is unclear.

**Stressor:** Highway construction and improvements
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Highway construction and improvements may adversely impact ashy dogweed populations (USFWS 2011). Since the largest, extant meta-population of ashy dogweed occurs along US 83, roadway improvement projects, highway maintenance, and potential urban

development have the potential to continue to impact the species.

**Stressor:** Development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The potential for development exists on private lands. An increase in development projects may increase the rate at which these populations are exposed to disturbance activities.

**Stressor:** Pesticides
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The use of herbicides to maintain ROW and control noxious weeds could directly harm a plant and could indirectly kill ashy dogweed pollinators or their host plants (USFWS 2011). Pesticide application to control crop pests, particularly aerial spraying and drift impacts, could also potentially impact populations if they are situated near agricultural areas.

**Stressor:** Oil and Gas Activity
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** When ashy dogweed was listed in 1984, oil and gas activity was not mentioned as a threat to the species. Since 1984, oil and natural gas activities have steadily increased in both Webb and Zapata counties impacting land cover and soils with the development of oil wells, well pads, oil and gas roads, vehicular traffic and/or hydraulic fracturing (“fracking”). The Environmental Protection Agency (EPA) is conducting a study examining the pollution effects of fracking on ground and surface water. Oil and gas activities do not currently occur within the US 83 ROW, but do occur on private lands and are considered significant threats to the ashy dogweed (USFWS 2011).

**Stressor:** Climate Change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change is considered to be a potential threat to ashy dogweed. “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level” (Intergovernmental Panel on Climate Change (IPCC) 2007). For the next two decades a warming of about 0.2°C (0.4°F) per decade is projected. After that time, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6°C to 4.0°C (1.1°F to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest United States may experience the greatest temperature increase of any area in the lower 48 states. The IPCC describes the likelihood that hot extremes, heat waves, and heavy precipitation events will increase in frequency. There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Climate change may act alone

or synergistically with the invasion of non-native invasive species to increase their spread and their ability to out-compete native varieties (Archer and Predick 2008). Temperature and precipitation changes, along with increases in atmospheric carbon dioxide and nitrogen, can enhance dispersal pathways for non-natives (Smith et al. 2000), allowing exotic plants to invade new areas and causing range reductions or possibly local extirpations of rare plant populations. Invasion of ashy dogweed habitat by buffelgrass has been described earlier. Due to its limited geographic distribution, and the fact that the largest number of individual plants occur in one meta-population, ashy dogweed is vulnerable to localized catastrophic events, such as flooding or drought, as well as to broader climate changes that could decrease suitable habitat, while simultaneously making conditions conducive to further exotic grass invasion. Extended periods of drought, becoming more common in South Texas also play a role in fire ecology by increasing the frequency, and potentially severity, of fires. Ashy dogweed's response to fire is unknown. However, most of the invasive grass species in south Texas appear to be positively fire adapted, so consequences of increasing drought conditions may include increasing the competiveness of these non-natives (Kuvlesky et al. 2002). Intensified and more frequent fire regimes can allow exotic grasses to form dense monocultures, including in areas where native species are able to persist. The increased amount of biomass and understory produced by these non-native grasses adds to the fuel load, and combined with a lack of precipitation forecast by potential climate change, could affect fire regime characteristics in ashy dogweed habitat including frequency, intensity, extent, type, and seasonality of fires (USFWS 2011). Climate change may also alter pollinator phenology (USFWS 1988). Since ashy dogweed appears to be insect pollinated, alterations in environmental conditions related to climate change, including precipitation and temperature, could alter the phenology of ashy dogweed such that the current blooming and fruiting patterns may not match the timing of pollinators that currently visit these plants, thereby stalling pollination (Sherry et al. 2007). Although it is reasonable to assume that ashy dogweed may be affected by climate change, we lack sufficient certainty to know how climate change will affect the species, and if so, to what extent.

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 5

**Recovery Actions:**

- The primary objective of the recovery plan for ashy dogweed is to protect this species and its habitat from further destruction from human activities and to establish healthy populations in their natural habitat at levels that would allow the species to be down-listed to threatened and eventually delisted (USFWS 1987).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The Service finds that impacts to the species from loss, fragmentation and/or alteration of habitat are continued threats to ashy dogweed. Current populations conditions remain unchanged and appear stable since the previous 5-year status review (Service, 2011). A complete evaluation of the biology through genetic studies, species monitoring on private lands and involvement with private landowners is recommended (USFWS, 2022).

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# SPECIES ACCOUNT: *Trifolium amoenum* (Showy Indian clover)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Pacific Southwest Region (R8)

**Physical Description**

An annual herb, 1-6 dm tall, hairy and often robust. Leaves are divided into 3 egg-shaped leaflets. Flowers (April-June) are purple with white tips and are borne in dense, round or oval heads, 2-3 cm long (NatureServe, 2015).

**Taxonomy**

A distinct species in a genus of about 300 species, most abundant in north temperate regions (NatureServe, 2015)

**Historical Range**

Historically in Alameda, Mendocino, Marin, Santa Clara, Solano, Sonoma, Napa counties, California (NatureServe, 2015)

**Current Range**

Currently believed extant only in Marin (native) and Sonoma (reintroduced) counties (NatureServe, 2015).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Self pollination and outcrossing (NatureServe, 2015)

**Reproduction Narrative**

Adult: Mating system appears to include both cross-and self-pollination, as extant plants were found to have a higher level of heterozygosity than would be expected in a predominantly self-pollinating species (Knapp and Connors 1999 cited in USFWS 2007).; Mixed selfing and outcrossing (NatureServe, 2015).

**Habitat Type**

Adult: Grasslands (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Serpentine soil (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species is typically in low, wet swales in grasslands. Also on grassy hillsides at up to about 400 m elevation. Per the California Dept. of Fish and Game (2000): Open, sunny sites, sometimes on serpentine soil in coastal bluff scrub and valley and foothill grassland; most recently seen on a roadside that had been graded and on an eroding cliff face. Possibly requires disturbance-created openings for germination (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of populations and individuals.

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Number of Populations:**

2 (USFWS, 2023)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015)

**Population Narrative:**

Historically known from 25 sites but probably extirpated at all but 1 of these (although some viable seed may remain in seedbanks and may germinate if conditions are right). Loss of habitat to urbanization and agriculture was probably the primary reason for the extirpation of so many populations. Even since 1997 when this species was listed as Endangered, much habitat potentially suitable for restoration has been altered and is now unsuitable due to urbanization, agricultural operations, and changes in the biological community and hydrological conditions (USFWS 2007). Decline of >90% The one native occurrence had about 225 plants when it was discovered in 1996 (California Dept. of Fish and Game 2000). Had been thought extinct until the early 1990s. A single plant was found in 1993 at a site in Sonoma County, but that site has now been developed and the species is considered extirpated there. However, seeds were collected from the plant prior to its extirpation and were subsequently multiplied. In 2006, some of those seeds were used to establish experimental populations at two sites in Sonoma County and at several sites at Point Reyes National Seashore (Marin County). It is as yet unknown whether any of the experimental sowings will persist (USFWS 2007). Another population, the only native population currently extant, was discovered in 1996 in Marin County. In 1997, seed from those plants was used to establish a small experimental population (approximately 20 seedlings) at

Bodega Marine Laboratory (Sonoma County) (USFWS 2007). The Bodega experimental population had persisted as of 2007, but its long term fate is unknown (USFWS 2007) (NatureServe, 2015). NatureServe (2015) also notes that the short-term trend for this species is a decline of 10% and the long-term trend is a decline of 90%. Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals. The species was considered extinct until 1993 when a single plant with the “erect” phenotype was discovered on privately owned property in Occidental, Sonoma County. Following the species’ discovery in Occidental, the locality site was developed, and the species is now extirpated from this site. Another native population with the “prostrate” phenotype was discovered in 1996 in Dillon Beach in Marin County on privately-owned property. The Dillon Beach population was the only known population at the time of listing (Service 1997, p. 55806). At the time of the Service’s previous 5-year review for the species in 2012 the Dillon Beach population was still extant, and the Service and its partners had established an outplanted population at Point Reyes National Seashore as well as another outplanted population at the Bodega Marine Reserve in Sonoma County that was extirpated by the time of the 2012 5-year review (Service 2012, p. 3). Currently, the distribution of the species is unchanged from the species’ previous 5-year review in 2012. Specifically, only the Dillon Beach and Point Reyes National Seashore populations, both possessing the “prostrate” phenotype, are known to remain in the wild (USFWS, 2023).

***Threats and Stressors***

**Stressor:** Urbanization (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Urbanization is listed as a threat to this species (USFWS, 2012).

**Stressor:** Agriculture (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Conversion of land to agriculture is listed as a threat to this species (USFWS, 2012).

**Stressor:** Erosion (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In addition to the threat from erosion of the hillside, in a 2010 annual report, Dr. Connors states the possibility of an earthquake that could result in a significant portion of the Dillon Beach population being lost in a landslide since it is very close to the eroding cliff (Connors 2010) (USFWS, 2012).

**Stressor:** Trampling (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A small trail providing local homeowners with access along the bluffs runs directly through the population. Although current use of the trail does not appear to threaten the

population, any increase in use or expansion of the trail could adversely affect the population (Connors 2006) (USFWS, 2012).

**Stressor:** Herbivory (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Herbivory by gophers and voles is listed as a threat to this species (USFWS, 2012).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The State's authority to conserve plants is comprised of four pieces of legislation: The California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA). Trifolium amoenum is not listed under CESA, therefore neither that Act nor the NPPA apply to this review. The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects to not only federally listed species, but also to those considered "rare" by other agencies or professional associations. Trifolium amoenum, although not state listed, is considered a List 1B plant by the California Native Plant Society. Any impacts to T. amoenum would be subject to evaluation through CEQA. The CEQA also requires the avoidance or mitigation of those impacts, where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. However, CEQA does not guarantee that such conservation measures will be implemented. Currently there are no completed regional or county-wide Habitat Conservation Plans per the Federal Endangered Species Act (HCPs) or Natural Community Conservation Plans (NCCPs) per the Natural Community Conservation Planning Act at any of the known occurrences (USFWS, 2012).

**Stressor:** Non-native exotic plants (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The most significant long-term threat to the Dillon Beach 10 population is invasion by the non-native Carpobrotus edulis (iceplant or sea fig). This plant, which competes for habitat with Trifolium amoenum, was planted for fire and erosion control in the adjacent yard and reached the T. amoenum population for the first time in 1999. Dr. Connors has developed an agreement with that landowner on an iceplant control program involving both hand-pulling and herbicide (Roundup) application (Connors 2006). Though the landowners do not follow any practices that would be harmful to the population, the status of iceplant removal is unknown. Other invasive competitors already present at the site, including Lolium multiflorum (Italian ryegrass) and Plantago lanceolata (English plantain), may gain in population size or density at the expense of T. amoenum (Connors 2006, in litt.). In addition, the non-native grass Holcus lanatus (velvet grass) is not currently at the site but has invaded many coastal bluff plant communities in the area. It could be a strong invader of the T. amoenum population if it became established at

the Dillon Beach site (Connors 2006) (USFWS, 2012).

**Stressor:** Small population size and few populations (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As discussed in the listing rule (Service 1997) and the 2007 5-year review, the conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). In these situations, genetic diversity can become dangerously low. Also, as Dr. Connors reports, annual plants like clovers naturally fluctuate annually, likely due to regional patterns in amounts and timing of rainfall (Connors 2010). Yearly fluctuations in the Dillon Beach population have been large, with occasional 15 to 20-fold changes between subsequent years. Seedling density was high and quite similar in 2007, 2009 and 2010, but much lower in 2008 (Connors 2010). Seed production has been even more variable. Trifolium seeds are typically long-lived in suitable soils, and the importance of a seedbank in sustaining this T. amoenum population has been demonstrated by the strong rebounds of the population in 2007 and 2009 (Connors 2010). However, if several years of low germination in a small population are followed by a disruption to or removal of the seedbank, genetic diversity may be further diminished. That Trifolium amoenum occurs in small numbers and at few locations has not changed since the time of listing or the last 5-year review. Therefore, threats associated with these factors remain. The combination of a single native population, small range, and restricted habitat makes this species highly susceptible to extinction or extirpation due to random events, such as flood, drought, disease, or other occurrences (USFWS, 2012).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2

Urbanization and land development. A1 The species persists in at least five total geographically-widespread populations (including the current Dillon Beach and Point Reyes National Seashore populations), as defined above. Each population possesses a minimum mean geographic coverage of 0.41 acre with a minimum density of 17 seedlings per square meter in survey transects over a five-year period including at least one below-average rain year for the population locality. This observation period must contain a below-average rain year in order to demonstrate the population’s ability to withstand this frequent stressor. (USFWS, 2025)

Erosion and geological events. A2 For each of the five populations described in Downlisting Criterion A1 above, there is a site-specific monitoring plan in place to monitor the effects of erosion on the population. (USFWS, 2025)

Trampling. A3 For each of the five populations described in Downlisting Criterion A1 above, there is a site-specific monitoring plan in place to monitor the effects of trampling and recreational activity on the population. (USFWS, 2025)

Non-native invasive species. A4 For each of the five populations described in Downlisting Criterion A1 above, there is a site-specific monitoring plan in place to monitor the effects of nonnative invasive species on the population. (USFWS, 2025)

**Delisting Criteria:**
A1 The species persists in at least five total geographically-widespread populations (including the current Dillon Beach and Point Reyes National Seashore populations). Each population possesses a minimum mean geographic coverage of 0.41 acre with a minimum density of 17 seedlings per square meter in survey transects over a ten-year period including at least two below-average rain years for the population locality. As in the downlisting criteria above, this observation period must include at least two below-average rain years to demonstrate the population's ability to withstand this frequent stressor. (USFWS, 2025)

A2 The geographic breadth of at least five total populations meeting the specifications described in Delisting Criterion A2 above are protected from incompatible uses through a formal agreement with the landowner such as a conservation easement or Conservation Benefit Agreement with the Service. (USFWS, 2025)

Erosion and geological events. A3 A site-specific management plan to control the effects of erosion on the species is developed and implemented for any populations threatened by erosion (e.g. the Dillon Beach population). (USFWS, 2025)

Trampling. A4 A site-specific management plan to control the effects of trampling and recreational activity on the species is developed and implemented for at least five populations meeting the specifications of Delisting Criterion A1 above (USFWS, 2025).

Non-native Invasive species. A5 A site-specific management plan to control the effects of non-native invasive species on the species is developed and implemented for at least five populations meeting the specifications of Delisting Criterion A1 above. (USFWS, 2025)

**Recovery Actions:**
- No approved final or draft recovery plan for Trifolium amoenum has been completed or is in preparation. (USFWS, 2012).
- 1) Complete and implement a recovery plan for T. amoenum which outlines specific recovery criteria and recovery tasks (USFWS, 2012).
- 2) Continue to monitor known populations of T. amoenum so as to discern population sizes and the differences between natural and unnatural population fluctuations (USFWS, 2012).
- 3) Conduct range-wide surveys to identify additional populations for protection and outcrossing purposes (USFWS, 2012).
- 4) Expand the genetic base of the Occidental population, currently used for reintroduction experiments, to prevent further loss of evolutionary potential and the possibility of deleterious effects associated with inbreeding. Any additional plants found as a result of (3) above should be used to expand the genetic variability. If no additional individuals are identified, the Dillon Beach population should be used. Much care must be used during this process, however, as phenotypic difference between the two populations are likely adaptive. Through "controlled introgression", a small proportion of the non-local Dillon Beach source seed could be mixed into the Occidental population over time, such that local adaptive variation is maintained while promoting adequate levels of within population genetic variation (Knapp and Connors 1999) (USFWS, 2012).

- 5) Reintroduce both growth forms into suitable habitat. The two forms of T. amoenum should be treated separately in any reintroduction efforts, however, because these forms have morphological differences which may be adaptive. The establishment of a self-sustaining population in a preserved area would greatly increase the likelihood of recovery of this species. Suitable habitats might be found at the Bodega Marine Laboratory or on State or Federal lands in the area (USFWS, 2012).
- 6) Conduct research into (a) the role of herbivory, (b) whether the presence of gophers is beneficial or detrimental, (c) reasons for interannual variability in population numbers and seed productivity, (d) the tolerance of T. amoenum to different soil types, and (e) the effect of disturbance regimes on T. amoenum, among other topics (USFWS, 2012).
- Action 1. Protect and manage existing populations of showy Indian clover (Priority 1). 1-1 Identify and execute opportunities to protect existing populations on private lands (i.e. the Dillon Beach population) through a formal agreement with the landowner such as a conservation easement or Conservation Benefit Agreement with the Service. 1-2 Identify and execute opportunities to protect existing populations on private and public lands by developing and implementing management plans for erosion and recreation effects on the species. (USFWS, 2025a)
- Action 2. Increase the number of existing showy Indian clover populations and the number of plants within each population (Priority 1). 2-1 Partner with local landowners and agencies to identify suitable areas for species outplanting and population augmentation. 2-2 Work proactively with partners to address regulatory issues which may arise from outplanting or population augmentation efforts. 2-3 Develop and implement greenhouse experiments as described in Action 5 below to identify key habitat needs of the species for germination and survival. 2-4 Partner with botanical gardens to multiply seed for outplanting and population augmentation. 2-5 Implement outplanting and population augmentation efforts, including population monitoring as described in Action 3 below. (USFWS, 2025a)
- Action 3. Conduct range-wide and long-term monitoring of showy Indian clover populations (Priority 2). 3-1 Identify partners to develop and implement a long-term monitoring program for showy Indian clover populations to observe trends in population abundance. 3-2 Identify and mark suitable long-term monitoring transects within each known population. 3-3 Survey monitoring transects both early and late during the flowering period (i.e. before and after seed set) to identify demographic trends in seedling mortality for each population each season. 3-4 Monitor the status of threats to populations such as invasive plants, erosion, and recreational use to inform management of these threats. (USFWS, 2025a)
- Action 4. Conduct rangewide field surveys (Priority 3). 4-1 Partner with local landowners and agencies to identify areas which contain suitable habitat for the species and obtain survey access to these areas. 4-2Conduct surveys of suitable habitat areas during the species' flowering season to identify any remaining wild populations. This action would also support recovery activity 2-1 above (identification of suitable areas for species translocation). (USFWS, 2025a)
- Action 5. Perform research on the fundamental biology of showy Indian clover throughout its known range (Priority 3). 5-1 Perform research on the specific habitat needs of the species. Specifically, research should address questions on the effects of grazing and herbivory on the species as well as the habitat needs of the species. 5-2 Perform research on how the habitat needs of the "erect" phenotype differ from the "prostrate" phenotype. 5-3 Perform experimental crosses to determine the "erect" phenotype's ability to cross with the "prostrate" phenotype. (USFWS, 2025a)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1) Continue to monitor the Dillon Beach and Point Reyes National Seashore populations and implement management strategies to address threats to these populations. 2) Identify potential outplanting areas suitable for both the “prostrate” and “erect” phenotypes of the species and outplant additional “prostrate” and “erect” populations. 3) Collect fresh seed to re-invigorate the species’ seed multiplication program and continue to store seed from the “erect” and “prostrate” forms in service of future outplanting efforts. 4) Conduct research into improving outplanting success rates such as identifying optimal soil geology and chemistry. 5) Perform breeding crosses and genetic analyses of “prostrate” and “erect” individuals to determine whether the differing phenotypes of the species reflect reproductive isolation. (USFWS, 2022)

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# SPECIES ACCOUNT: *Trifolium trichocalyx* (Monterey clover)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Pacific Southwest Region (R8)

**Physical Description**

A prostrate, spreading annual herb. The prostrate branches are sometimes only 3-4 cm long, but can reach 30 cm under favorable conditions. Flowers are borne in heads, 4-14 mm wide, the pale purple petals barely extending beyond the bristly calyces. Blooms April-June. (NatureServe, 2015)

**Taxonomy**

Trifolium trichocalyx (Figure 7) was first collected by Amos A. Heller in 1903 following a fire 2 years earlier "in sandy pine woods about Pacific Grove" (Heller 1904). The species was described by Heller the following year (Heller 1904). Laura F. McDermott considered the taxon a variety of T. oliganthum in her treatment of the genus (McDermott 1910), although this classification was not recognized in subsequent floras. Axelrod (1982) reported at least one researcher who suggested that Monterey clover was a sporadic hybrid between T. microcephalum and T. variegatum and recommended removing it from the list of Monterey endemic taxa. This view was challenged by V. Yadon (in litt. 1983) who had grown T. trichocalyx and observed it consistently producing up to seven seeds per pod, while both putative parent plants were two-seeded taxa. Trifolium trichocalyx has continued to be recognized as a distinct species by Abrams (1944), Munz and Keck (1959), Howitt and Howell (1964), and Isely (1993), and we accept it as such (USFWS, 2004).

**Historical Range**

Monterey clover was historically only known from a 206 acre area in Monterey County (Figure 1) (Service 2009, p. 2) on land that is now largely owned and managed by the Del Monte Forest Conservancy and the Pebble Beach Company. In 2011, Monterey clover was identified along logging roads during botanical surveys for a timber harvest plan in Mendocino County, approximately 200 miles (mi) north of the historical range (USFWS, 2025).

**Current Range**

Monterey clover) is known from only one area (Huckleberry Hill) covering approximately 16 hectares (40 acres) on property owned by the Pebble Beach Company on the Monterey Peninsula. During 1996, two locations in the Huckleberry Hill area with a total of 22 plants were located (USFWS, 2004). In 2011, Trifolium trichocalyx was identified along logging roads in Mendocino County. Additional populations have since been found in Mendocino but the population sizes and area remain restricted. (USFWS, 2019). Monterey clover occurs in the understory of Monterey pine (Pinus radiata) forest in Monterey County (Service 2009, p. 6) and along logging roads in mixed forest of coast redwood (Sequoia sempervirens), Douglas fir (Pseudotsuga menziesii), and tanoak (Notholithocarpus densiflorus) in Mendocino County (Heise et al 2012, p. 167). The common element between the two locations is recent disturbance that results in low canopy cover and reduced competition for light from other species both native and non-native. The disturbance regime has been based on fire cycles (Service 2004, pp. 37-38) in Monterey County, while in Mendocino County the disturbance regime has resulted from the construction and use of logging roads (Service 2020, pp. 7-8). It is possible that Monterey clover is more widespread in both Monterey and Mendocino Counties but has gone undetected either from lack of surveys or presumed absence based on habitat type. The variation in associated species between the two locations suggests that habitat requirements may not be as strict as previously described (USFWS, 2025).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Trifolium trichocalyx flowers between April and June (USFWS, 2004).

**Reproduction Narrative**

Adult: Trifolium trichocalyx appears to regenerate in large numbers during spring following a fire that removes the dense vegetative cover that shelters its seed bank. Trifolium trichocalyx populations will decline as shrubs and seedlings overshadow the plants as the forest begins to recover following a fire. Trifolium trichocalyx appeared after the 1901 fire and again after the 1987 fire, thus possibly harboring a seed bank capable of surviving more than 90 years. Recent studies indicate light as the only germination requirement (Doak et al. 2000). However, seeds buried in the soil at Huckleberry Hill may require different germination cues than those seeds used in germination experiments because experimental seeds were never buried (Doak et al. 2000). Trifolium trichocalyx flowers between April and June. Small bees are likely pollinators as they are with other Trifolium clover species, although no pollinators were observed in previous studies (Jones and Stokes Associates 1996). Additionally, scarification may stimulate some Trifolium trichocalyx to bloom between fires (V. Yadon in litt. 2002) (USFWS, 2004).

**Habitat Type**

Adult: Pine forest (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Fire dependent (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits openings in and edges of Monterey pine forest. Ephemeral: plants persist for a few years following fire or other vegetation removal, but are shaded out or outcompeted after that. Soils are poorly drained, coarse loamy sands. < 100 m elevation (NatureServe, 2015).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Trifolium trichocalyx becomes scarce when the forest canopy closes, persisting primarily as a seed bank in the soil while shade and competition increase during succession of the forest community (USFWS, 2004).

***Population Information and Trends***

**Population Trends:**

Increasing in new locations, decreasing in other locations (USFWS, 2025)

**Number of Populations:**

2 (USFWS, 2025)

**Population Size:**

Thousands (USFWS, 2025)

**Population Narrative:**

The Service considers there to be two populations of Monterey clover, one population in Monterey County and another in Mendocino County with multiple sublocations (Figure 1). The sublocations in Mendocino County relate to monitoring areas for timber harvest plans rather than biological or geographical boundaries. In Monterey County, Monterey clover is under surveyed and information on abundance since listing in 1998 is sparse. We do not break out sublocations for the Monterey population because of the lack of abundance information coupled with inaccurate historical spatial data. Despite multiple survey attempts through 2022, no Monterey clover have been observed in Monterey since 2016 when only 23 individuals were identified (McCabe 2017, pp. 2-6) (Table 1). Prior to 2016, Monterey clover was only documented in 1987 (several hundred to a thousand) and in 1996 (22) (Service 2004, p. 37). The lack of observations may be due to a lack of continuous survey effort but may also reflect a stabilization of the habitat from lack of disturbance that results in higher canopy cover and greater understory competition inhibiting germination and growth (USFWS, 2025).

***Threats and Stressors***

**Stressor:** Urban and recreational (e.g., golf courses) development (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The Recovery Plan (Service 2004) identifies the most significant threat to the species has been the loss of potential habitat from urban and recreational (e.g., golf courses) development. At the time of listing, less than 20 percent of the historical Monterey pine forest on the Monterey Peninsula was estimated to remain, much of it in fragmented and increasingly isolated stands (Jones and Stokes Associates 1994 in Service 1998). Jones and Stokes Associates

(1996) estimated that habitat for the species has declined approximately 69 percent, from 1,754 acres (710 ha) to 539 acres (218 ha) as of 1996. Of locations mapped for the species, the majority of occurrences appear to be within the Huckleberry Hill Natural Reserve and Morse Reserve; however, individuals have been identified adjacent to the south of the Huckleberry Hill Natural Reserve. A number of plants are presumed to have been extirpated when the Poppy Hills Golf Course was developed in 1980 (Service 2004). The Service is unaware of any potential habitat losses since the species was listed in 1998 (USFWS, 2009).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** At the time of listing, regulatory mechanisms thought to have some potential to protect Trifolium trichocalyx included: (1) listing under the California Endangered Species Act (CESA); (2) the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA); (3) the California Coastal Act; and (4) local land use laws, regulations, and policies. The listing rule (63 FR 43100) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid. Trifolium trichocalyx was listed as endangered by the State of California in 1979. As such, projects that would affect Trifolium trichocalyx are subject to CESA and CEQA requirements. The lead CEQA agency with primary authority or jurisdiction over a project is responsible for conducting a review of the project and to consult with other agencies concerned about resources affected by the project. However, required biological surveys are not always adequate to identify the presence of Trifolium trichocalyx, as the species is not visible above ground while it exists as seed banks. In addition to the laws and regulations discussed above, local county regulations may also benefit Trifolium trichocalyx. This species occurs within a portion of the Monterey Peninsula included in the California Coastal Zone. The Del Monte Forest Land Use Plan of 1984 was developed to comply with the Coastal Act’s requirement that all counties prepare a plan for those portions of the Coastal Zone within their jurisdiction. Once the Del Monte Forest Land Use Plan was certified by the CCC, development permits within the Del Monte Forest coastal zone became the responsibility of the County of Monterey. The County of Monterey also has designated certain areas, including a portion of where Trifolium trichocalyx is known to occur, as ESHAs. Although the County of Monterey recognizes the importance of these areas, protection of listed species through the California Coastal Act and local land use designations is dependent upon the review of the lead agency involved. Additionally, while no development projects have been implemented in the area where Trifolium trichocalyx occurs since the time of listing, State and local regulations may not protect the species from indirect impacts that occur from such threats as changes in hydrology in adjacent areas and the spread of nonnative species (USFWS, 2009).

**Stressor:** Alteration of fire frequency (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of populations
**Narrative:** At the time of listing, the alteration of natural fire cycles was identified as a significant threat to the species’ survival. The species is only known to occur within an area bordered by residential development and Pebble Beach Company facilities (e.g., golf courses, structures). This fact combined with the limited remaining habitat makes this species extremely susceptible to

stochastic events. Trifolium trichocalyx seed banks within the Huckleberry Hill area are apparently viable after an extended period of time; however, due to fire suppression, the normal fire cycle in Monterey pines has been lengthened. Due to the lack of knowledge on the species, it is unknown what effect the lack of a natural fire regime will have on seed viability. In the absence of fire, or a reasonable habitat disturbance alternative, this species could become extirpated at certain locations or potentially be rendered extinct (CDFG 2005) (USFWS, 2009).

**Stressor:** Small numbers of individuals and populations (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of genetic diversity
**Narrative:** Conservation biology literature discusses that small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). Based on historical records, we believe that urban and recreational development on the Monterey Peninsula has already reduced the distribution of this species in the area where it occurs. Indirect effects from urbanization in the Huckleberry Hill area could include changes in hydrology, vegetation, and an increase in nonnative species. While any one of these factors may not be enough to threaten the survival of Trifolium trichocalyx independently, its limited range and the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of the species (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species’ distributions will shift in response to climate change, specifically that the species will “move” or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to Trifolium trichocalyx at this time (USFWS, 2009).

**Stressor:** Climate change (USFWS, 2009)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:**

***Recovery***

**Reclassification Criteria:**
1. At least five viable populations (i.e., populations that are stable or increasing based on a minimum of 12 years of monitoring) occur in suitable habitat. One of these populations is the Huckleberry Hill population (USFWS, 2009).

2. All five of the sites are on land that is protected from human-induced disturbance (i.e., development, recreation) that would negatively affect growth or reproduction of the plants. Funds must be available for appropriate long-term management. As determined by research, protected habitat must be of adequate size (large enough to support a functioning ecosystem [e.g., species present to support seed dispersal and pollination, areas that support fluctuating distributions, areas that harbor suitable unoccupied habitat for population expansion]) and configuration to ensure that ecosystem and community processes and associated species (e.g., hydrologic regime, fire, food webs, pollinator fauna, Monterey pine forest communities) are maintained, and that an adequate diversity of sites exist for population expansion and for colonization of new areas as microhabitat conditions change (USFWS, 2009).

3. The Huckleberry Hill population and four additional viable populations (as described in 1 above) have been managed so as to allow regeneration of plants and replenishment of the seed bank found in the soil within protected habitat (USFWS, 2009).

4. A seed bank has been established at a recognized institution certified by the Center for Plant Conservation (USFWS, 2009).

Recovery Priority Number: 5C

**Delisting Criteria:**
Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. We currently do not know what the specific habitat needs are for this species. To the best we know now, the most outstanding management need currently is: a) integrate, or find a replacement for, a fire regime as a means of revitalizing declining or senescing colonies; and b) research on soil seed bank dynamics and conditions for germination. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts; the area in Mendocino County where colonies were discovered in 2011 should be assessed, as well as the Monterey Peninsula area. Also, two additional, new populations are established and protected where appropriate. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. Assuming that habitat was being managed to incorporate a fire regime to increase openness and to release fire-adapted seed, we would then expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

**Recovery Actions:**

- No other populations have been discovered or re-introduced within the known historic range of the species; therefore, this criterion has not been met. Ensuring that five viable populations occur in suitable habitat may be relevant; however, the complexities associated with identifying discrete populations of this ephemeral plant make it difficult for us to measure this criterion. This criterion may need to be revised in future recovery plans and could be based on preserving all or portions of the species remaining potential habitat (USFWS, 2009).
- As discussed above, we currently have no appropriate method for measuring five viable populations of the species; therefore, this criterion may need to be revised in future recovery plans. The majority of Trifolium trichocalyx occurrences are within areas that have been permanently protected by easements (i.e., Huckleberry Hill Natural Reserve and Morse Reserve). However, we believe that any further development in the Huckleberry Hill area of the Monterey Peninsula would directly reduce the species remaining habitat. Undeveloped areas within the vicinity of Huckleberry Hill that are not protected by easements are important for potential expansion of the species, and we believe they require protection. Additionally, funds dedicated for long-term management of the species in protected areas have not been committed. This criterion has not been met (USFWS, 2009).
- As stated in criteria (1) and (2) above, we have no suitable method to determine five distinct populations of this ephemeral species. Currently, the areas where Trifolium trichocalyx is known to occur is not being managed to allow regeneration of plants and replenishment of the seed bank. This criterion has not been met (USFWS, 2009).
- Currently Trifolium trichocalyx seed is being stored at the Plant Genetic Resources Conservation Unit located on the Griffin Campus of the University of Georgia. Additionally, Trifolium trichocalyx seed is being stored at the U.S. Department of Agriculture's National Center for Genetic Resource Preservation in Fort Collins, Colorado. This criterion is relevant and up-to date. This criterion has been met (USFWS, 2009).
- 1. Work with Pebble Beach Company, Del Monte Forest Foundation, Pebble Beach Community Services District, and Pebble Beach residents to develop and implement a fire management plan that would mimic natural fire regimes within the Huckleberry Hill area. If a burn management plan is not implemented, burn box experiments should be conducted to determine where the species occurs within the Huckleberry Hill area (USFWS, 2009).
- 2. Surveys for Trifolium trichocalyx should be conducted following fires and/or following substantial scarification of potential habitat on the Monterey Peninsula (USFWS, 2009).
- 3. Experiment with establishment of new populations in similar habitat on the Monterey Peninsula or at Point Lobos State Reserve. If these efforts are successful, attempts to establish other populations could be undertaken on the Monterey Peninsula (USFWS, 2009).
- 4. Germination trials should be conducted that mimic natural soil conditions and germination cues to establish more clearly the conditions needed to facilitate germination (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-Year Review: 1. Annual surveys should be conducted within the historical range in Monterey County with attention given to areas where disturbance within the past 5 years is known to have occurred. 2. Annual surveys for populations in Mendocino County continue with attention given to frequency of use and any management actions taken. 3. Potential suitable habitat is identified and surveyed in areas between the northern and southern boundaries. 4. Seed from both populations are collected and stored within a seed bank. 5. Germination and outplanting strategies should be developed if an adequate amount of seed can be collected. Outplanting and monitoring should be attempted at potentially suitable habitat in both Mendocino and Monterey Counties. (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-Year Review: 1. Conduct regular annual surveys in Monterey and Mendocino Counties where the species is known to occur. Surveys should include estimates of abundance, spatial information, associated species, threats, description of disturbance drivers, and general habitat conditions/land use. 2. Conduct surveys for Monterey clover in areas where there is suitable habitat in both Monterey and Mendocino Counties. Logging roads within suitable habitat, both active and inactive, as well as dirt access roads or hiking paths may offer relatively easy survey targets. 3. Identify and survey potential suitable habitat in areas between the northern and southern populations. 4. Collect seed from Monterey, Big River, and Garcia Section 11 store within a conservation seed bank. 5. Develop germination and outplanting strategies if an adequate number of seed can be collected. Design and implement outplanting and monitoring experiments at potentially suitable habitat in both Mendocino and Monterey Counties. (USFWS, 2025)

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# SPECIES ACCOUNT: *Verbena californica* (Red Hills vervain)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 10/14/1998; California/Nevada Region (R8) (USFWS, 2016)

**Physical Description**

A perennial herb, 3-7.5 dm tall, that produces spikes of blue to purple flowers. Blooms May-September. (NatureServe, 2015)

**Taxonomy**

Verbena californica is a narrowly distributed biennial or perennial herb belonging to the vervain family (Verbenaceae). Verbena californica was first discovered in 1938 in Tuolumne County, California (Moldenke 1942) (USFWS, 2008).

**Current Range**

Currently, the entire range of Verbena californica is presumed to be an area of about 77 square kilometers (30 square miles) or 12 kilometers (7.5 miles) by 6.4 kilometers (4 miles). Within this narrow range, the total area occupied by the populations is estimated to be 50 hectares (124 acres) (CNDDB 2011). Verbena californica grows at elevations between 255 and 400 meters (837 to 1,310 feet) (CNDDB 2011). Most of the sites are within the expanded Red Hills Area of Critical Environmental Concern (ACEC) that now consists of about 4,042 hectares (9,988 acres, about 15.6 square miles) of public land south of the historic town of Chinese Camp in Tuolumne County (BLM 2011) (USFWS, 2012).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Breeding Season**

Adult: Formerly, the species was thought to also reproduce vegetatively through rhizomes, but Knox (1998) found no evidence of rhizomes when she dug up plants. In nature, seed germination has been observed as early as mid-October and probably continues throughout the winter (Knox 1998). The progress of seedling maturation has not been reported. Plants mature and can begin flowering by late May, with flowering continuing through September (Stone 1992; Tibor 2001) (USFWS, 2012).

**Reproduction Narrative**

Adult: Knox (1998) determined that soil moisture was the primary factor influencing the distribution and reproduction of this species. Underground springs were responsible for maintaining summer water flow in the stream reaches she studied. Nine of the total 11 V. californica occurrences are along streams in Pinus sabiniana (foothill pine) woodlands (USFWS, 2008). Seeds apparently are the primary means of reproduction for Verbena californica. Formerly, the species was thought to also reproduce vegetatively through rhizomes, but Knox (1998) found no evidence of rhizomes when she dug up plants. In nature, seed germination has been observed as early as mid-October and probably continues throughout the winter (Knox 1998). The progress of seedling maturation has not been reported. Plants mature and can begin flowering by late May, with flowering continuing through September (Stone 1992; Tibor 2001). Flowering begins at the bottom of the flower cluster and progresses upward through the season (Stone 1992). Dates of seed formation in nature have not been reported, although transplants grown in an outdoor garden had mature seeds present in July (Knox 1998). Considering that each flower can produce as many as four seeds, Knox (1998) estimated that potential seed production at her three study sites ranged from 282 to 1,245 seeds per plant. The lowest estimate was at an atypical site in a meadow with compacted soils and severe competition (Knox 1998). Seed dispersal mechanisms are not known for V. californica (USFWS, 2012). Availability of pollinating insects is important for reproduction. Pollination of Verbena californica has not been studied in great detail, but insects visiting the flowers, and possibly transferring pollen, include butterflies, flies, beetles (Stone 1992), and bees (Moldenke 1972). The most frequent visitors according to Stone (1992) were butterflies in the genus Ochlodes (woodland skippers; family Hesperiidae). However, Moldenke (1972) reported only bees visiting the flowers of V. californica in 1970 and 1971, including two species of leafcutting bees (family Megachilidae), Anthidium edwardsii and Chalcidoma angelarum, and two cuckoo bees (family Anthophoridae), Anthophora urbana and Melissodes lupina (USFWS, 2012).

**Habitat Type**

Adult: Woodland/grassland (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Serpentine substrates (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species occurs along intermittent and perennial streams with serpentine substrates. 260-400 m elevation. Cismontane woodland, valley and foothill grassland / mesic, usually serpentine seeps or creeks; elevation 260-400m (California Native Plant Society 2001) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species limited number of populations and the species specific habitat requirements.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Seed dispersal mechanisms are not known for V. californica (USFWS, 2012).

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2012)

**Number of Populations:**

15 presumed occurrences (USFWS, 2022)

**Population Size:**

2500 - 10,000 individuals (NatureServe, 2015)

**Population Narrative:**

The abundance of Verbena californica is much the same today as it was when it was listed and 15 sites are presumed extant (A. Franklin in litt. 2007; CNDDB 2011). However, other sites may have been extirpated in the past without having been documented. We believe that current populations likely have been fragmented and reduced in size from those that existed historically (USFWS, 2012). Low resiliency, redundancy and representation are inferred based on this species specific habitat needs and low number of populations. The current species distribution of Red Hills vervain is an area of about 82 square kilometers (32 square miles) or 9.7 kilometers (6 miles) by 8.6 kilometers (5.3 miles) in and around the Red Hills of Tuolumne County, similar to what we described in our 2012 review (Service 2012, p. 4). See Figure 1 for a map of distribution. Within this narrow range, the total area occupied by the species is estimated to be 85 hectares (210 acres) (Diversity Database 2021). At the time of listing, the species was known from nine occurrences across a range of about 16 kilometers (10 miles) (Service 1998, p. 49023). One of the described occurrences is known only from an herbarium specimen collected in 1972 and no details on habitat, population size, or threats are available (Diversity Database 2021). Similar to our 2012 5-year review, for the purposes of this 5-year review we do not consider this specimen an extant occurrence. At the time of our 2007 and 2012 5-year reviews, there were 11 and 15 presumed extant occurrences, respectively (Service 2007, p. 4; Service 2012, p. 5). The number of extant Diversity Database occurrences of Red Hills vervain has not changed since the 2012 5-year review (i.e., there are 15 presumed extant sites). Of these, nine occurrences have been verified since the 2012 5-year review and further fieldwork is necessary to determine the status of the other six occurrences. At the time of listing, about 85% of Red Hills vervain were on private lands (Service 1998, p. 49023). Now, most of the sites are protected within the Red Hills Area of Critical Environmental Concern that consists of about 4,042 hectares (9,988 acres, about 15.6 square miles) of public land south of the historic town of Chinese Camp in Tuolumne County. The Red Hills Area of Critical Environmental Concern is managed by the Bureau. The Bureau designated the southern 1,821 hectares (4,500 acres) of the Red Hills as an Area of Critical Environmental Concern in 1985, which was then expanded to its current range in 1993 (Service 2012, p. 11). The purpose of the designation is to protect the unusual serpentine soils and the rare or listed species that rely on the habitat, including rare plants, Red Hills roach (Hesperoleucus symmetricus ssp.), and bald eagles (Haliaeetus leucocephalus) (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Recreational gold mining (USFWS, 2012)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Placer gold mining, which includes panning and dredging along streams, is a potential threat to occurrences of Verbena californica on lands administered by the BLM (J. Willoughby, BLM, in litt. 1990; California Department of Fish and Game 1993; A. Franklin, in litt. 2007). In the course of gold panning, the plants themselves can be trampled or dislodged and soil can be compacted. Currently, the California Department of Fish and Game is prohibited by court order from issuing suction dredge permits. Panning of gold along streams is still allowed (USFWS, 2012).

**Stressor:** Adjacent development (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Hydrological changes remain a threat to the Andrew Creek occurrence. Although the Verbena californica population is no longer threatened directly by residential development, runoff from the proposed houses and golf course on the table land above the drainage may affect the riparian area. Lowering of the water table that feeds springs in the riparian area is also a concern (California Department of Fish and Game 2005). The direct threat from housing development has decreased since listing. The Verbena californica habitat that was formerly on private land within the Andrew Creek drainage became public land in 2000. The acquisition was a cooperative effort among the BLM, the Tuolumne County Land Trust, the Trust for Public Lands, the California Wildlife Conservation Board, the Packard Foundation, and the California Department of Transportation (A. Franklin, in litt. 2002). In 2004, the Tuolumne County Land Trust acquired part of the Big Creek population with funding from the California Department of Transportation (E. Cypher, California Department of Fish and Game, pers. comm. 2006, 2007) (USFWS, 2012).

**Stressor:** Grazing (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals/degradation of habitat
**Narrative:** Currently, grazing on the BLM lands in the Red Hills occurs within two leases, one of which has Verbena californica. This lease is for 72 animal unit months over 1,178 acres within the Red Hills ACEC. Monitoring of V. californica, which began in 1998, uses a comparison of 2 grazed and 2 ungrazed (fenced) plots to evaluate grazing effects (BLM 2007b). No clear pattern of grazing effects has emerged from monitoring, i.e., it is not clear that the grazed or ungrazed plots are resulting in greater viability (BLM 2007b). However, grazing clearly does impact plants of V. californica. Clipped stems of V. californica have been observed both in the experimental plots and in other areas subjected to grazing. Trampling damage has been observed especially for the wet ground where V. californica occurs. Because the phenology of V. californica is relatively late, the grazing period was moved forward and now ends on April 15. We determined that the grazing program may adversely affect V. californica. No new grazing leases will be authorized in the Red Hills (BLM 2007b; Service 2007); however, the existing leases still remain (Peggy Cranston, Wildlife Biologist, Mother Lode Field Office, BLM, pers. comm. 2012) (USFWS, 2012).

**Stressor:** Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)

**Exposure:**
**Response:**
**Consequence:** Loss of habitat/Loss of individuals
**Narrative:** The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as threatened in 1998. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of listing under the Endangered Species Act (USFWS, 2012).

**Stressor:** Climate change (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The global average temperature has risen by approximately 0.6 degrees Celsius (1 degree Fahrenheit) during the 20th Century (IPCC 2001, 2007; Adger et al. 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001, 2007; Adger et al. 2007), and that it is “very likely” that it is largely due to manmade emissions of carbon dioxide and other greenhouse gases (Adger et al. 2007). Ongoing climate change (Inkley et al. 2004; Kerr 2007; Adger et al. 2007; Kanter 2007) likely imperils Verbena californica and the resources necessary for its survival. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of its habitat and/or increased numbers of its predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat, or in the case of plants the inability to disperse to newly suitable habitat at a rate equal to advance of newly unsuitable habitat caused by the change in environmental conditions (USFWS, 2012).

**Stressor:** Non-native plants (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:**

**Stressor:** Small populations (USFWS, 2012)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991; Ellstrand and Elam 1993). Populations that are continually small in size are particularly susceptible to genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes (e.g., undergo population bottlenecks). Increased homozygosity (reduced genetic variation) resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993) (USFWS, 2012).

**Stressor:** Recreational activities (USFWS, 2012)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Red Hills have mostly been used for recreation. Until 1991, the main recreational uses were target-shooting, off-road vehicle driving, camping, hunting, hiking, horseback riding, nature study, wildflower viewing, and hobby prospecting. In 1991, to protect the fragile biological resources of the area, target shooting and off-road vehicle use were prohibited on public land in the Red Hills (BLM 2009). Presently the main recreational activity in the Red Hills is equestrian use. Hiking, mountain biking and spring wildflower viewing are other popular activities (BLM 2007b). Overnight camping is no longer allowed within the Red Hills ACEC (BLM 2008) (USFWS, 2012).

**Stressor:** Herbivory and trampling (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, the primary threats to Red Hills vervain throughout its range include: herbivory and trampling during unmanaged cattle grazing (USFWS, 2022).

**Stressor:** Drought (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drought is listed as a primary threat to this species (USFWS, 2022).

**Stressor:** Fire, flash floods, competition with nonnative plants (USFWS, 202)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Currently, the primary threats to Red Hills vervain throughout its range include: herbivory and trampling during unmanaged cattle grazing, drought, fire, flash floods, competition with nonnative plants, recreation, gold mining, and climate change (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 14

**Recovery Actions:**

- No recovery plan or outline has been completed for this species (USFWS, 2012).
- Work with the BLM to revise the Red Hills ACEC management plan to include new data, new listings of species under the Endangered Species Act, newly acquired lands, and other lands added to the ACEC because of newly developed resource information (USFWS, 2012).
- Encourage the BLM to withdraw habitat from mining patents (USFWS, 2012).
- Establish reliable baseline data for monitoring plant occurrences. Monitor the status and trend of Verbena californica in order to track any threats, and to estimate current population sizes, the number and distribution of populations, and whether the species is stable, increasing, or declining (USFWS, 2012).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Red Hills vervain. Some of these recommendations have already been discussed in previous 5-year reviews (Service 2007; Service 2012) and remain valid. 1. Verify Red Hills vervain occurrences recorded in the California Natural Diversity Database, especially occurrences with a currently unknown status, that have not been surveyed in the previous ten years, and/or that are on private land. 2. Establish reliable baseline data for monitoring Red Hills vervain occurrences. Monitor the status and trend of occurrences to (a) track any threats, (b) estimate current population sizes and the number and distribution of populations, and (c) determine whether the species is stable, increasing, or declining. 3. Research the hydrology of watersheds and streams in the Red Hills Area of Critical Environmental Concern to predict how climate change will impact water availability to Red Hills vervain. Monitor seasonal and yearly changes to stream flows. 4. Mitigate cattle grazing impacts on Red Hills vervain by maintaining the fence demarcating the boundary between the Red Hills Area of Critical Environmental Concern and private ranch lands at Diversity Database occurrence #12. Continue to monitor Diversity Database occurrence #8 for grazing impacts. 5. Determine the extent of impact of nonnative grasses on Red Hills vervain. Work with the Bureau to continue to monitor and control yellow star thistle, especially those adjacent to Red Hills vervain. Determine whether and where Red Hills vervain is impacted by Bermuda grass and panic grass to establish a management plan. 6. Create a management plan for recreational activities in the Red Hills Area of Critical Environmental Concern to mitigate the impact of recreational activities, including hiking, mountain biking, and equestrian use, on Red Hills vervain. Work with the Bureau to identify appropriate actions, such as signage and fencing to limit access to sensitive habitat areas. 7. Identify potential locations for outplanting and translocation of Red Hills vervain based on known habitat preference information, in case these activities are necessary due to irreversible change to current habitat, such as those due to climate change. 8. Determine length of seed viability in storage. Currently, Red Hills vervain seeds are stored at the University of California Botanical Garden at Berkeley (USFWS, 2022)

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# SPECIES ACCOUNT: *Warea amplexifolia* (Wide-leaf warea)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 05/29/1987; Southeast Region (R4)

**Physical Description**

Warea amplexifolia is an annual herb in the mustard family (Brassicaceae). Plants may be 30 to 100 cm tall and the stalk may be unbranched or, more often, branching midway up the stem. Leaves are alternate, from 2 to 5 cm long, and 1 to 3 cm wide, smaller as they ascend the stalk, with a rounded apex and entire margin. On young plants, the leaves are slightly folded along the midrib, tipped upward, and the lobes at the base of leaves reach around the stem. This characteristic has led to one of the common names for the species, clasping warea. The heart-shaped clasping leaf bases and its pale green, slightly glaucous leaves readily distinguish W. amplexifolia from the three other species in its genus in Florida. The characteristic leaves can be used in field identification even if the plants are not flowering. The pale lavender flowers of W. amplexifolia vary in individuals from almost white to almost purple. Flowers appear at the ends of the branches in spherical clusters about 5 to 6 cm across. Superficially, the flowers look like small versions of the garden cleome (Cleome hasslerana), a member of the family Capparaceae. The inflorescences are dainty, and in the field the flowering plants look almost fluffy. Individual flowers are about 1.5 cm across, with four petals and six long stamens. Warea amplexifolia is also readily identifiable in seed, even as the stalk turns brown and the leaves wither, by the clusters of narrow down-curving seed pods, from 5 to 7 cm long. The pods split longitudinally, with small black seeds on either side of the center membrane. (USFWS, 1999)

**Taxonomy**

Warea amplexifolia was originally described by Thomas Nutall in 1822 from a specimen collected in central peninsular Florida by N.A. Ware. Nutall at first placed this plant in the genus Stanleya, but in 1834 transferred it to the genus Warea and provided an amplified description that accommodated specimens from the Florida panhandle. The panhandle specimens were later recognized as a distinct species, Warea sessilifolia, by Nash. Shinners (1962) proposed a new name for the peninsular species, Warea auriculata, but most authors consider W. amplexifolia the correct name (Payson 1922, Channel and James 1964, Judd 1980). (USFWS, 1999)

**Historical Range**

Judd (1980) believed the former range of W. amplexifolia included Lake County, western Orange County, extreme northwestern Osceola County, and northern Polk County, Florida. (USFWS, 1999)

**Current Range**

Endemic to the Lake Wales Ridge of central Florida in Lake, Orange, and Polk counties (USFWS, 2017)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Sexual (Produces seeds) Abiotic (wind), Biotic (Hymenoptera; Lepidoptera) (USFWS, 1999)

**Lifespan**

Adult: Annual (USFWS, 1999)

**Breeding Season**

Adult: Flowering occurs from mid-August to early October, and fruiting occurs from late September to mid-November (USFWS, 1999)

**Reproduction Narrative**

Adult: Warea amplexifolia flowers from mid-August to early October, and fruiting occurs from late September to mid-November. Senescence occurs just before the fruit matures, and the population overwinters as seeds. The showy flowers are pollinated by various Hymenoptera (bees) and Lepidoptera (butterflies). Reproduction is exclusively sexual, with seeds probably released from the pods by wind action. The small seeds generally fall near the parent plant (FWS 1986). Experimental propagation to field plots at Bok Tower Gardens suggests that the number of flowering plants is related to the amount of rainfall during the December prior to the growing season. They also found that plants grew from seeds that had been sown into the experimental plots 2 to 4 years earlier, which indicates that seed banking in the soil is important in this species (Bok Tower Gardens 1994). (USFWS, 1999)

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Oak sandhills and sand pine-scrub oak scrub (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Sunny openings with exposed sand in longleaf pine/turkey oak sandhills and sand pine-scrub oak scrub. (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/Specialist (NatureServe, 2015)

**Habitat Narrative**

Adult: Warea amplexifolia is endemic to high pine ecosystems of Florida. The high pine refers to the hilly portions of the ecosystem rather than the stature of the pines themselves. The undulating xeric sand ridges supporting the high pine are known as sandhills and the entire community is referred to by the same term. Sandhills are maintained under natural conditions by frequent patchy summer fires sparked by lightning. The resulting habitat condition is an open, often sparse over-story plant assemblage of longleaf pine (Pinus palustris), longleaf pine/turkey oak (Quercus laevis), or live oak/bluejack oak (Q. geminata/Q. incana) with an open, park-like understory. The ground cover consists of perennial grasses and forbs interspersed with deciduous clonal oaks (Myers 1990). Warea amplexifolia occurs on welldrained, sterile, yellow sands and is typically widely scattered in the sunny openings of the sandhills. (USFWS, 2017)

***Dispersal/Migration***

**Motility/Mobility**

Adult: Moderate (NatureServe, 2015)

**Dispersal**

Adult: Abiotic (wind) (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Seed is dispersed by wind (NatureServe, 2015)

***Population Information and Trends***

**Number of Populations:**

9 naturally occurring (USFWS, 2022)

**Population Size:**

over 10,000 individual plants (USFWS, 2017)

**Population Narrative:**

The most recent data suggest there are over 10,000 plants in the 9 extant natural populations (Peterson 2016); however, the Warea Tract in Lake County and the Ocklawaha property (Ocklawaha North EOR #28 and Ocklawaha South EOR #30) in Marion County typically account for greater than 95% of the plants range-wide. Lake Griffin State Recreation Area historically had a larger population, but the recent surveys suggest the population appears to be declining. The remaining six populations generally have low population numbers. (USFWS, 2017). Nine extant populations that were documented in the previous 5-year review (2017) still persist. Four populations occur on public lands while the remaining five are in private ownership. Current plant counts for these locations are not included in this reporting. The Florida Forest Service Warea Tract in Lake County and the Ocklawaha Corridor in Marion County (Duke Energy and private ownership) are the largest populations and account for ~95% of the plants range-wide (USFWS, 2022).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat destruction, modification, and degradation on private lands remain the primary threat to the species range-wide. Populations occurring on private lands remain subject to habitat destruction or fragmentation due to development. In addition, the absence of habitat management on private lands results in unsuitable conditions for the species to successfully

flourish and reproduce. Publicly owned conservation lands typically are afforded controlled access and may even have enforcement personnel on-site to prevent destructive activities. These lands also have management plans to create, restore, or maintain desirable habitat conditions; however, budget shortfalls and staffing constraints may preclude beneficial activities in some years. Also, depending on the management plan for various public lands, not all public conservation lands where the species occurs are specifically managed to benefit W. amplexifolia. The management is often a balance of the multiuse activities occurring on the sites and prioritized accordingly to available budget and respective mission (e.g. state park, state forest, county or city utility property, etcetera). Currently, four of the extant populations (Lake Griffin State Recreation Area, Warea Tract, Sugarloaf Mountain, and Schofield Sandhill) occur on public lands, four populations (Ferndale Ridge, Bissett Property, Mountain Lake Estates, and Ocklawaha North and South) are under private ownership, and one population (Twin Lakes) occurs on private property and in a road/utility easement. (USFWS, 2017)

**Stressor:** Inadequacy of existing regulatory mechanisms
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Florida Administrative Code 5B-40 (Preservation of Native Flora of Florida) provides the Florida Department of Agriculture and Consumer Services (FDACS) with limited authority to protect plants on State and private lands (primarily from the standpoint of illegal harvest). Warea amplexifolia is listed as an Endangered Plant under this statute, which requires anyone wishing to "willfully harvest, collect, pick, remove, injure, or destroy any plant listed as endangered growing on the private land of another or on any public land or water" to "obtain the written permission of the owner of the land or water or his legal representative" (FAC 5B-40.003(1)(a)). A permit is also required to transport "for the purpose of sale, selling, or offering for sale any plant contained on the endangered plant list which is harvested from such person's own property" (FAC 5B-40.003(1)(c)). (USFWS, 1999)

**Stressor:** Other natural or manmade factors
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Drought, fire suppression, and invasive plant species encroachment continue to negatively affect W.amplexifolia populations. The Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (Pachauri et al. 2014). Effects associated with changes in climate have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, and wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (Pachauri et al. 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change (Byers and Norris 2011; Anacker et al. 2012). However, while continued change is certain, the magnitude and rate of change is unknown in many cases. The magnitude and rate of change could be affected by many factors (e.g., circulation patterns), but we have no additional information or data regarding these factors with respect to W.amplexifolia. There is evidence that some terrestrial plant populations have been able to adapt and respond to changing climatic conditions (Franks et al. 2013). Both plastic (phenotypic change such as leaf size or phenology) and evolutionary (shift in allelic frequencies)

responses to changes in climate have been detected. Both can occur rapidly and often simultaneously (Franks et al. 2013). Relatively few studies are available, however, that (1) directly examine plant responses over time, (2) clearly demonstrate adaptation or the causal climatic driver of the responses, or (3) use quantitative methods to distinguish plastic versus evolutionary responses (Franks et al. 2013). (USFWS, 2017)

***Recovery***

**Reclassification Criteria:**
1. When 10 geographically distinct, self-sustaining populations are protected and managed (USFWS, 1993).

Recovery Priority Number: 2C

**Delisting Criteria:**
1. When 20 such populations are protected and managed, and each has been monitored for at least 8 years. Recovery will require a minimum of 10 years (until 2003), if establishment of new populations is prompt and obviously successful (USFWS, 1993).

**Recovery Actions:**

- Determine current distribution of W. amplexifolia. Conduct surveys of W. amplexifolia. Maintain distribution of known populations and suitable habitat in GIS database. Use GIS to map existing populations and to assess the species? status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the FNAI database. Currently, the Lake Wales Ridge Ecosystem Working Group and Archbold Biological Station are proposing to map the entire central ridge. This information would show potential habitat for scrub and high pine endemics based on their habitat needs. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding areas has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. (USFWS, 1999)
- Continue research on life history characteristics of W. amplexifolia. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Continue monitoring the existing populations of W. amplexifolia. Evaluate the effectiveness of the monitoring protocol used to assess population trends for W. amplexifolia. Monitor and detect changes in demographic characteristics., such as growth, survival, and mortality. Monitor the effects of various land management actions on W. amplexifolia. Continue to work with private landowners. Monitor introduced plants. (USFWS, 1999)
- Provide public information about W. amplexifolia. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery

of W. amplexifolia and other rare species require a self- sustaining, secure, number of natural populations. (USFWS, 1999)

- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Secure habitat through acquisition, landowner agreements, and conservation easements. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and high pine and their unique biota. (USFWS, 1999)
- Revise the current recovery plan to include objective and measurable recovery criteria that are related to reducing and/or eliminating threats to W. amplexifolia as well as updated on the species distribution and ecology (USFWS, 2007).
- Provide funding and technical support for further research on: The effects of prescribed burning and other management tools on W. amplexifolia. Continue working with public managers to increase the management on their sites. Additional life history needs. Information is needed on how W. amplexifolia plants and seeds are affected by years of drought. Genetic inbreeding depression. This information will help us determine what constitutes a stable population. The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitats. The various pollinators (e.g. Hymenoptera and Lepidoptera), as well as how different species assist with seed dispersal (USFWs, 2007).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2007).
- Update the range-wide survey, that was completed by Dr. Jack Stout in 200, on all known and potential sites occupied by W. amplexifolia and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2007).
- Consider reintroduction and monitoring of W. amplexifolia on additional publicly owned lands with suitable habitat. Prior to reintroduction, research on the microhabitat needs of W. amplexifolia should be considered. Reintroduction of W. amplexifolia could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2007).
- Acquisition and management of the remaining known populations on private lands. Areas within the Ocklawaha and Ferndale Ridge developments where native sandhill habitat still exists would be the primary areas to target near-term. (USFWS, 2017)
- Active management of the four natural populations on public lands to maintain or create openness of the habitat and to control the invasive plant species encroachment. (USFWS, 2017)
- Yearly monitoring of the natural populations and the introduced populations on public lands will be necessary to accurately determine future population viability. (USFWS, 2017)
- Continued research on life history, biology, and ecology (population genetics, seed germination, spatial seedling recruitment patterns, demography, pollination biology, microhabitat factors, etcetera). (USFWS, 2017)
- Update range-wide survey to determine number of extant populations and individual plant abundance at each location. (USFWS, 2017)
- . Continue population introductions and population augmentations. (USFWS, 2017)
- Compare sites with long-term data sets from different locations within close proximity to one another and their associated management to increase the understanding of the ecological conditions that influence population abundance. (USFWS, 2017)

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES • Acquisition and management of the remaining known populations on private lands. Areas within the Ocklawaha and Ferndale Ridge developments where native sandhill habitat still exists would be the primary areas to target near-term. • Active management of the four natural populations on public lands to maintain or create openness of the habitat and to control the invasive plant species encroachment. • Update range-wide survey to determine number of extant populations and individual plant abundance at each location. • Continue collaboration with Duke Energy Corporation on compatible habitat management activities within the Ocklawaha Corridor population occurring in their right-of way (USFWS, 2022).

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# SPECIES ACCOUNT: *Warea carteri* (Carter's mustard)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 2/20/1987; Southeast Region (R4)

**Physical Description**

Warea carteri is an annual herb, 0.2 to 1.5 m tall with erect green stems. The plants usually have many slender, ascending branches forming an open, rounded crown. The leaves lack stipules and are arranged alternately on the stem. Lower leaves are lost by the time the plant flowers. Leaf size and shape varies with age and position on the plant. At the time of flowering, leaf petioles range from 0.8 to 3.9 mm with blades 1to 3 cm long. Towards the tips of stems, the leaves are smaller and narrowly elliptical to almost linear, while closer to the bases of stems and branches, the leaves are larger and oblanceolate or spatulate. All leaves are rounded at the tip, their margins entire, and their bases attenuate to cuneate. The lower leaves can also be undulate, margined or lobed. The many inflorescences of W. carteri are dense, rounded racemes with many flowers (60 or more). The flowers are radially symmetric, with four white linear-oblanceolate sepals, about 4.5 mm long, and curved toward the center of the flower at the tip. The four petals are white, about 6.0 mm long, with more than half their length in the form of a slender claw. The petal’s blade is nearly round with irregular margins. The six spreading stamens are irregularly subequal in length and arise from a nectar-producing floral disc. The ovary is superior, cylindric, about 2.3 mm long, and raised on a slender stalk (gynophore) about 2 mm long. The sessile stigma has two lobes. W. carteri is protandrous: the anthers begin to dehesce within an hour or two after the flower has opened. The stigmas are receptive until 2 to 4 days afterwards, by which time the stamens on that flower have dropped. Warea carteri’s fruit is a silique, long, slender pod divided lengthwise by a partition (septum). The pod is flattened, cylindrical in cross-section and gently curved along its length, which is 4 to 6 cm long and 1.5 mm wide. The pod is borne on a gynophore, which is a stalk-bearing pistil 5 to 6 mm long,above a spreading pedicel, which is around 8.5 mm long.The pod carries numerous oblong seeds, each 1.5 mm long (Kral 1983). Fruits split apart passively to shed the seeds. (USFWS, 1999)

**Taxonomy**

Warea carteri was named by Small in 1909. A review of the genus by Channel and James in 1964 retained Small’s treatment of the species. There are no scientific synonyms (Nauman 1980). Common names for the species include Carter’s mustard, Carter’s warea, and Carter-warea. (USFWS, 1999)

**Historical Range**

Carter's mustard was once found in Miami-Dade County, Florida, as well as Lake, Polk, and Highland Counties, Florida. Extirpated from extirpated from Miami-Dade County.

**Current Range**

On the Lake Wales Ridge in Lake, Polk, and Highlands counties, Florida (USFWS, 2019).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Self-pollinating

**Breeding Season**

Adult: Flowering occurs in September and October. Fruiting occurs in October and November (USFWS, 1999)

**Other Reproductive Information**

Adult: Large fluctuations observed in above ground population size suggest the possibility that seed banking plays a significant role in W. carteri's biology. Environmental cues necessary for germination were explored experimentally at Archbold Biological Station. Moisture and light were found to be necessary for germination. The use of an oak leachate did not significantly affect germination. Some seeds stored in dry, dark conditions for 2 years germinated, demonstrating the potential of W. carteri's seeds to remain dormant at least that long. Fire-related cues such as heat do not stimulate germination, but germination does require light and seeds may remain dormant for more than 2 years. (USFWS, 1999)

**Reproduction Narrative**

Adult: Experiments have demonstrated that Warea carteri is self-pollinating, autogamous, and self-compatible (Evans et al., in press). Autogamy and self-compatibility allow isolated or sparsely distributed individuals to reproduce. Natural levels of fruit- and seed-set are quite high, with a fruit-set of 62 percent, and seed-set of 50 percent (Evans et al. in press). Self-pollinated flowers showed significantly lower fruit- and seed-set, 41 percent fruit-set and 28 percent seed-set. This indicates that insect-mediated pollination is important in keeping fruit- and seed-set high, and individual fecundity high. Pollinators appear to be the limiting factor in fruit and seed production. Because aboveground populations fluctuate wildly, autogamy helps ensure fecundity and may be a key life history trait. Germination in W. carteri occurs in late winter through early spring (January-March). Flowering occurs in September and October. Fruiting occurs in October and November, and dispersal follows in November and early December (Kral 1983). Preliminary observations of insect activity on W. carteri indicate it is a generalist with respect to pollination. A great diversity of insects visit the flowers, including native solitary bees, bumblebees, syrphids (known as hoverflies or bee-flies), wasps, flies, beetles, etc. Within-plant movements by insects appear to predominate over among-plant movements. Because of this, and in combination with the close proximity of male and female flowers in an inflorescence, self-pollination probably is a regular method of reproduction in this species. (USFWS, 1999)

**Habitat Type**

Adult: Upland sandy areas; xeric, shrub-dominated habitats

**Environmental Specificity**

Adult: Moderate (inferred from USFWS, 1999)

**Habitat Narrative**

Adult: Carter’s mustard is found almost exclusively in upland areas and is a soil generalist, being found on yellow, gray, or white sands (Menges et al. 2007). It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. This is also true for sites at Tiger Creek Preserve, a site in the central part of its range, which supports the greatest number of plants. At this site, the species is found in both high-quality, frequently burned sandhill, as well as in overgrown sandhill that could also be termed xeric hammock (Menges in litt. 2008d). Near the south end of its range (e.g., ABS), Carter’s mustard is fond primarily in scrubby flatwoods, often just downhill from a ridge of yellow sand (Menges in litt. 2008e). These habitats have a range of fire return intervals from 2 to 15 years (Menges 2007). Although Carter’s mustard has a large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire (Menges in litt. 2008f). Although preferring post-fire or disturbed sites, Carter’s mustard is not a gap specialist. Plants often grow among dense shrubs in scrubby flatwoods or shrubby sandhill sites.

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: There are no obvious specialized forms of seed dispersal in W. carteri. The siliques do not open explosively; rather, the external walls of the fruit peel away from the central septum as the fruit slowly dries, exposing the mature seeds inside. The seeds drop passively to the ground or they may be flung a bit further if the plant is brushed. It’s not likely that seeds are moved by wind once they reach the ground. Collection or movement of seeds of W. carteri by ants or other animals has not been studied, but there are no obvious specialized structures on the seed that would encourage such movement. (USFWS, 1999)

***Population Information and Trends***

**Number of Populations:**

50 known occurrences (USFWS, 2019)

**Population Narrative:**

The most recent FNAI Element Tracking Summary (FNAI 2015) reported 50 known occurrences for Carter's mustard, of which 41 were found on 12 managed areas. Historical populations in Brevard and Miami-Dade Counties are believed extirpated. Although Carter's mustard has large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire . Carter's mustard populations fluctuate widely from year to year. For burned populations especially, these fluctuations are biennial (peak every two years) and dampen over time. Fires usually initiate cycles, with the largest population sizes occurring the year following fire. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

**Stressor:** Limited geographic range.
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation

seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

***Recovery***

**Reclassification Criteria:**

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to assure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of W. carteri are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the scrubby flatwoods and turkey oak dominated high pine to support W. carteri (USFWS, 1999)

4. When monitoring programs demonstrate these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually reproducing at sufficient rates to maintain the population (USFWS, 1999)

Recovery Priority Number: 2

**Delisting Criteria:**

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**

- Determine current distribution of W. carteri. Some portions of W. carteri’s range have been well surveyed, yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of W. carteri. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species’ more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of W. carteri. (USFWS, 1999)
- Provide public information about W. carteri. It is important for the recovery of this species that governmental agencies, conservation organizations, and private landowners be

appropriately informed about this species. (USFWS, 1999)

- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat and ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Better land management is needed so that protected populations remain extant. Periodic burning is recommended to ensure that aboveground populations are replenished before seed banks decline. Adaptive management can be used based on data collected on Carter’s mustard responses to various fire regimes. • Data on management activities (e.g., fire, mechanical treatments) should be gathered in management units where level 2 monitoring is being done. These can serve to link information specific to those units, including population size and trends, with detailed demographic models that are keyed to management (e.g., prescribed fire). • Detailed demographic data from three sites (Quintana-Ascencio et al. 2008) could be used as the basis of a population viability analysis that addresses questions such as how Carter’s mustard responds to different fire regimes and what is the prognosis for populations of different sizes. They could also be used to make specific predictions for populations where there were estimates of population sizes. • For some or all managed sites, collection of additional data on population sizes (level 2 monitoring). These data are being collected at two sites (LWRSF and TNC Tiger Creek Preserve. For Carter’s mustard, level 2 monitoring will have to be concentrated in September and October, when plants are visible and more easily counted. • More data on the response of Carter’s mustard to management activities such as roller chopping, mowing, gyro-tracking, logging, and chain-saw felling. • If significant unprotected populations of Carter’s mustard are discovered, these populations should be protected by land purchase or management agreements. (USFWS, 2021)

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17 pp.

# SPECIES ACCOUNT: *Ziziphus celata* (Florida ziziphus)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 8/28/1989; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

Ziziphus celata is a spiny shrub that averages between 0.5 to 1.5 m in height, but can grow to over 2 m. Plants occur in groups of stems, arising from what are assumed to be connected root systems. The primary branches are jointed and bent, and give rise to short, straight, spiny, branchlets. The oblong-elliptic to obovate leaves are alternate and deciduous. The leaves are characterized by rounded tips, cuneate bases, and entire margins. The upper leaf surface is dark glossy green, while the underside is a dull light green. Leaves vary from 4.5 to 21 mm in length, and from 3 to 13 mm in width. Fragrant Z. celata flowers are small, axillary, and solitary, but are tightly bundled on short shoots. Flowers are perfect, with five greenish-yellow sepals, and five white petals clasping five stamens; however, three-and four-merous flowers have been observed (Race and Weekley 1996). The bright yellow drupes range from 10 mm to 20 mm long, and 3 mm to 10 mm wide (Judd and Hall 1984, DeLaney et al. 1989, Race and Weekley 1996). (USFWS, 1999)

**Taxonomy**

Ziziphus celata was originally collected near Sebring in 1948. A second specimen was collected in 1954, perhaps from the same site as the original specimen, but the location of the latter collection is unknown. The plant remained unidentified and unnamed until 1984, when Judd and Hall (1984) named the original herbarium specimen Ziziphus celata. When it was named, the Florida ziziphus was thought to be extinct. However, it was rediscovered in 1987 at a site in Polk County (DeLaney et al. 1989). (USFWS, 1999)

**Historical Range**

See Current Range.

**Current Range**

Florida ziziphus is known only from a few sites on the Lake Wales Ridge in southern Polk and northern Highlands counties, in Florida. (USFWS, 2019)

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Reproductive Strategy**

Adult: Insect pollinated; Asexual (USFWS, 1999)

**Breeding Season**

Adult: Begins to flower in late December or early January and flowering continues through late February (varying by site and year), while the branches are still bare.

**Other Reproductive Information**

Adult: Research on the genetics, reproductive biology, and demography of Florida ziziphus for over a decade has quantified limited genetic variation in the wild populations. Breeding system experiments have demonstrated that Florida ziziphus is self-incompatible and that most genotypes are also cross-incompatible. The combination of limited genetic variation and a limited range of mating types explains why most populations are self-sterile. Demographic research has shown that populations are stable with high survival but variable levels of clonal recruitment. Without augmentation, most populations are predicted to undergo slow decline in numbers (Menges 2012). (USFWS, 2019)

**Reproduction Narrative**

Adult: Ziziphus celata is deciduous, losing its leaves in late fall. It begins blooming in late December or early January and blooming continues through late February (varying by site and year), while the branches are still bare (Burkhart et al. 1997). Fruits begin to develop in March, with new leaves forming at the same time or soon after. The fruits ripen in May or early June. No seedlings have been found in the wild, so it is not known whether the seeds germinate in the summer or later in the year. Common pollinators (bees and flies) have been observed visiting the flowers, although it is not known if these are pollinators of Ziziphus. No viable seeds have been observed in the wild. Natural fruit set has been observed twice in the wild, but few fruit were produced, and of those all aborted before maturity. Lack of sexual reproduction may be due to the absence of compatible genotypes at a given site and/or the age of the above ground stems (Burkhart et al. 1997). Ziziphus celata spreads asexually by sending shoots up from its roots. These additional stems give Z. celata a clump-like appearance, where individual plants in the clump are not distinguishable. Like other members of its genus, Z. celata is capable of parthenocarpic production of fruit, but it differs from others in its genus by not being dichogamous, having pistils and stamens that mature at different times to prevent self-fertilization (Burkhart et al. 1997). (USFWS, 1999)

**Habitat Type**

Adult: Oak-hickory scrub

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2019)

**Habitat Narrative**

Adult: Florida ziziphus is a thorny clonal shrub found only on yellow sand xeric habitats that historically supported longleaf pine/wiregrass sandhills and similar vegetative communities. Most Florida ziziphus habitat has been converted to citrus groves and cattle ranches. (USFWS, 2019)

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

13 wild, 3 introduced (USFWS, 2024)

**Population Narrative:**

Florida ziziphus is known only from a few sites on the Lake Wales Ridge in southern Polk and northern Highlands counties. Only four of the 14 known populations occur in publicly protected sites. Most populations are self-sterile due to limited genetic diversity and the isolation of population. The most recent FNAI Element Tracking Summary (FNAI 2015) reported 10 known occurrences for Florida ziziphus, of which 5 are protected at 4 different managed areas. In addition, four new populations have been established since 2008. Florida ziziphus has been reintroduced using.transplants and seeds to four sites, including The Nature Conservancy's Tiger Creek Preserve, the Lake Wales Ridge State Forest, and the Lake Wales Ridge NWR. (USFWS, 2019) In 2009 there were 14 extant populations. Since that review, the monitoring schedule for the plant has been altered to be less frequent than previously, and the most recent survey data are from 2021. As of 2021, there are 13 extant wild populations and 3 introduced populations (Table 1; Heron pers. comm 2024). This is a reduction from the 16 documented wild populations because three of those located on private lands have been extirpated (Herron pers. comm 2024). Several of the extant wild populations also occur on private land and are at risk of loss. These populations are vital to recovery, as plants on public property represent a small fraction of genetic diversity. The Masterpiece site (including the Masterpiece North and South populations), which has a conservation easement, supports over half of known plants and much of the genetic diversity in this species. Most populations on privately owned sites have declined steadily over the past decade (Smith et al. 2013) and will continue to decline without efforts to promote sexual reproduction (Ellis et al. 2007). The recent transfer of the Gulfstream/Mitigation site to the Service has also aided in the conservation of Florida ziziphus. This parcel is now known as the Arbuckle unit and is part of the Everglades Headwater National Wildlife Refuge. Several translocations of Florida ziziphus have occurred (Table 2; for details, see David and Herron 2023). Only one plant remains from the initial augmentation at one of the Avon Pines sites, and it is unclear whether the second augmentation has yet resulted in sexually mature and reproducing plants. Two larger augmentations at Arbuckle Everglade Headwaters National Wildlife Refuge in 2003 and 2006 have been successful in flowering, producing fruit, and producing one second generation seedling. However, survival has been relatively low in this disturbed sandhill (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19

percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

**Stressor:** Lack of adequate fire management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

**Stressor:** Limited geographic range
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire is necessary to maintain the scrub habitats upon which short-leaved rosemary, Avon Park harebells, Garrett's mint, scrub mint, snakeroot, Highlands scrub hypericum, scrub blazing star, Lewton's polygala, wireweed, sandlace, Carter's mustard, and Florida ziziphus depend. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species, including short- leaved rosemary, Avon Park harebells, Garrett's mint, scrub mint, snakeroot, Highlands scrub hypericum, scrub blazing star, Lewton's polygala, wireweed, sandlace, Carter's mustard, and Florida ziziphus. (USFWS, 2019)

**Stressor:** Fire suppression or lack of adequate fire regime (USFWS, 2024)
**Exposure:**
**Response:**

**Consequence:**
**Narrative:** Fire suppression is a continuing threat to the habitat of Florida ziziphus. In studies of Florida ziziphus introduced to one sandhill site, Menges et al. (2008) found that resprouting oaks encroached with negative effects on plant survival. The number of oaks increases under fire suppressed conditions. Fire return intervals for Florida ziziphus should be in the 5- to 20-year range (Menges et al. 2020), however most private property owners do not apply prescribed fire at this frequency. Fire suppressed conditions will likely continue on most private sites, to the detriment of potential Florida ziziphus habitat. Prescribed fire implementation on some public lands is behind schedule due to insufficient resources coupled with logistical obstacles. Smoke, public safety, and property liability issues, along with public perceptions relating to aesthetics still pose obstacles to implementing prescribed fire (USFWS, 2024).

**Stressor:** Invasive plants (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Non-native invasive plant species are a threat to Florida ziziphus at sites, especially those that are adjacent to modified landscapes and those that have been converted to pasture. In pastures, the dominant groundcover of pasture grasses may be a factor in the lack of recruitment from seeds in the few reproductive populations, but this has not been investigated. In addition, non-native vines pose a threat and can grow over Florida ziziphus. These vines compete for sunlight, space, water, and nutrients and may cause a decrease in the survival and reproductive success of Florida ziziphus. Invasive plants are managed at the protected sites and are not a significant threat to Florida ziziphus at these sites (USFWS, 2024).

**Stressor:** Paucity of recruitment from sexual reproduction (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Few fruits and seedlings have been documented in populations. Because populations are fragmented and beyond likely pollination distance, crosses among populations only occur when plants are brought together or manually pollinated. The destruction of unprotected populations on private land could result in additional loss of genotypes critical to conservation and recovery of the species. In particular, if the remaining genetic diversity drops, sexual reproduction may become impossible further threatening the species (USFWS, 2024)

**Stressor:** Climate change (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Effects of climate change on the habitat of Florida ziziphus are not known. Increases in temperature and changes in precipitation patterns could be important in the future. Forecasts of more severe droughts and higher rainfall between droughts could mean that fires would be more severe and that prescribed fires harder to control. This could harm Florida ziziphus populations. Sea level rise in coastal Florida is already a reality and may lead to an increase in development in interior Florida, thus increasing the vulnerability of Florida ziziphus habitats (Volk et al. 2017). The National Climate Assessment (Melillo et al., 2014) reports that the average precipitation has decreased in central Florida since 1900; however, heavy downpours are increasing in frequency

and intensity since 1970. Future projected precipitation changes in seasonality for central Florida indicate 0 to +10% in winter, 0 to -10% in spring, -10 to -20% in summer, and +10 to +20% in fall will occur. Statewide annual rainfall is projected to increase from 0 to +20% by 2100. In additional to changes in precipitation, Florida has undergone increases in average temperatures since the beginning of the 20th century (Runkle et al. 2022). Warming is expected to increase in the future and will result in declines in soil moisture loss. Consecutive dry days are expected to increase 10 to 20% for most of Florida. Predictions of increased drought frequency, intensity, and duration could result in plant losses due to prolonged drought conditions (Melillo et al., 2014). However, this plant and other xeric species are relatively drought-resistant, but seasonality changes may affect seedling recruitment and general phenology of the species. Although Florida's coastal areas will likely be influenced by sea level rise, based on our understanding of current sea level rise models and the species occurrences inland on well drained soils (e.g., ancient ridges mainly in central Florida), sea level rise does not currently pose a threat to this species. The Service has no direct evidence that climate changes observed to date have had any adverse impact on the species or its habitat (USFWS, 2024).

***Recovery***

**Reclassification Criteria:**
Not defined. (USFS, 1999)

Recovery Priority Number: 5

**Delisting Criteria:**
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in sand hill habitat are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

**Recovery Actions:**
- Determine current distribution of Z. celata. It is possible that populations of this species have yet to be discovered. Currently, three of the sites for Z. celata are in pastures and the other two are in restricted remnant areas. A complete survey has not been made of the Lake Wales Ridge for this species, making defining a distribution difficult. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. Within the islands of xeric habitat, this species is found in only two remnant natural sites and three pastures sites, indicating how little habitat is left for Z. celata. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Continue research on life history characteristics of Z. celata. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)

- Continue monitoring existing populations of Z. celata. (USFWS, 1999)
- Provide public information about Z. celata. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about Z. celata. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of Z. celata and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

***Conservation Measures and Best Management Practices:***

- RECOMMENDED FUTURE ACTIVITIES Recovery actions outlined in the initial recovery plan (Service 1999) and the amendment to the recovery plan (Service 2019) are mostly ongoing or partially complete. Stakeholders (e.g., state agency, private conservation groups) are actively working toward the recovery of this plant, including maintaining ex situ collections, monitoring, and protecting existing populations. Recovery Activities • Continue to maintain captive populations to use for reintroductions and/or to increase genetic diversity at extant sites. • Maintain regular fire-return intervals across the inhabited landscape Monitoring and Research Activities • Continue regular census of extant populations, determine genetic makeup of populations. • Search appropriate habitat types in private lands (that have yet to be scouted) for potential additional populations. • Monitor sites post-fire to understand how long after fire FL ziziphus will recover/resprout. • Maintain collaboration and data sharing agreements with state agencies and the Archbold biological station to ensure that all data on monitoring of extant populations are collated and shared with appropriate parties (USFWS, 2024).

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